AS/400e

How to TCP/IP on the AS/400

Scott Sylvester
AS/400 Software Development
sylvests@us.ibm.com

© Copyright IBM Corporation, 2000. All Rights Reserved.

This publication may refer to products that are not currently available in your country.
IBM makes no commitment to make available any products referred to herein.

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Agenda

- Why is TCP/IP important?
- What can you do with AS/400 TCP/IP?
- Example Deployment Scenario
- Focus on New AS/400 TCP/IP Functions
- Focus on TCP/IP-based Solutions
- Tips and Hints
- Where to Find Additional Information
- Reference Material

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

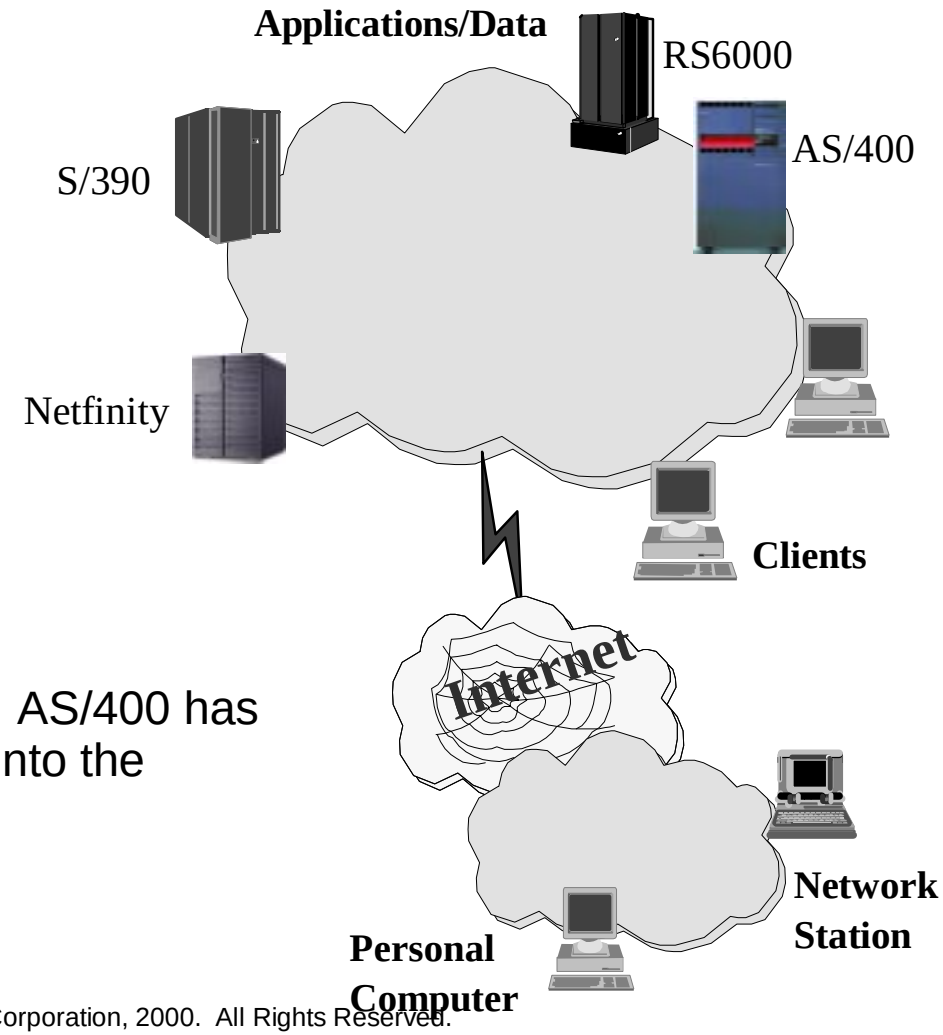
But Why do I need TCP/IP?

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 TCP/IP

Key to the New Application Model

- **Internet**
- **intranet**
- **Web Applications**
- **Lotus Domino**
- **Heterogeneous Computing**
- **IBM Network Stations**
- **Universal Access**
- **Network Cost Management**
- **New Distributed Applications**
- **Secure Access**



Many require TCP/IP in some form. AS/400 has excellent TCP/IP support built right into the operating system.

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Cool TCP/IP Stuff that comes with AS/400

Instant Intranet - Just add Cables!

Built for e-business

Fast & Robust Networking

Web Server

Mail Server

File Server

IP Printing

Terminal Emulation

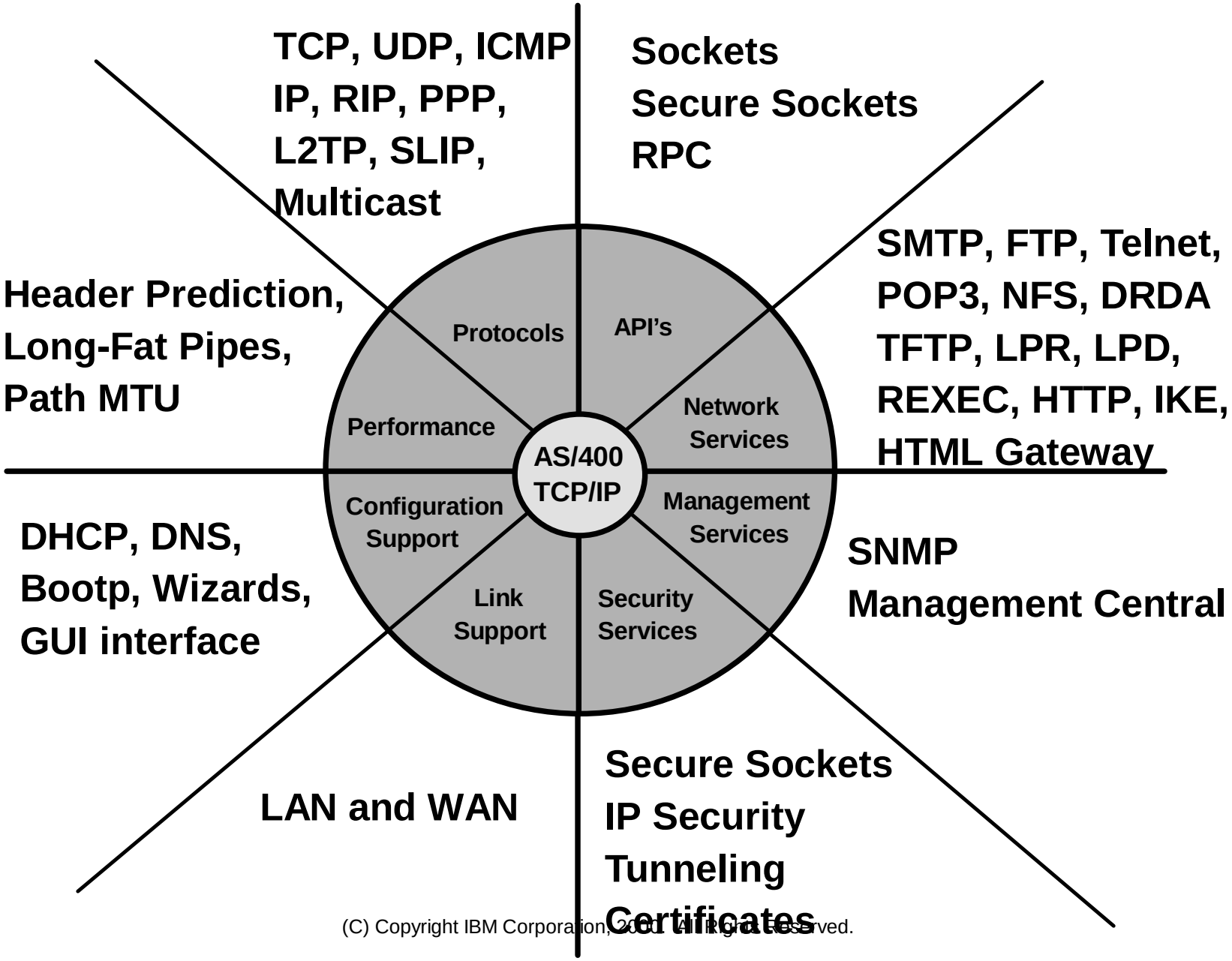
Database Access

Java Execution Environment

and more...

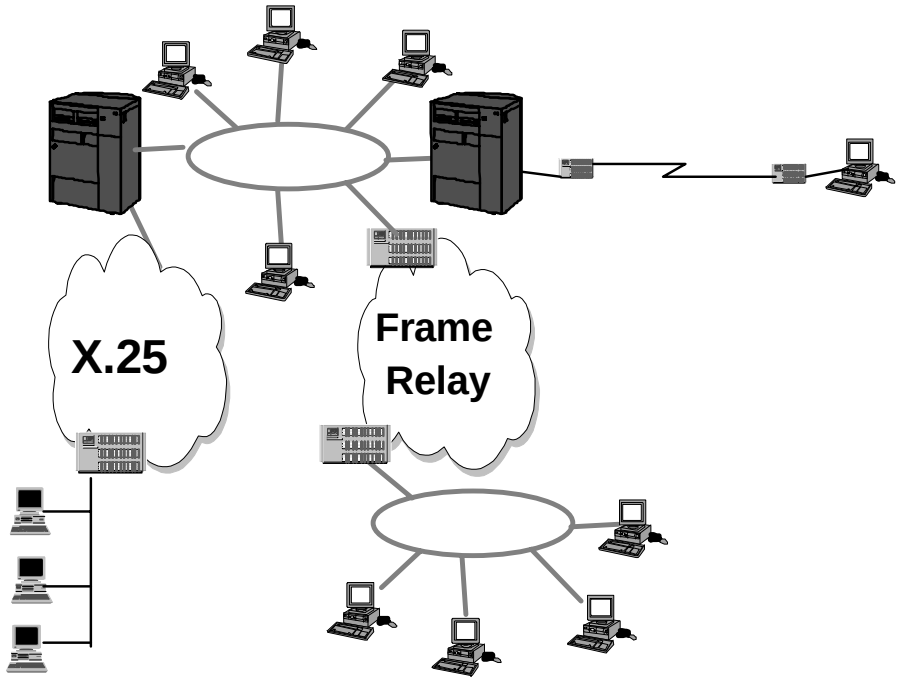
(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 TCP/IP support: standards-based



(C) Copyright IBM Corporation, 2001. All rights reserved.

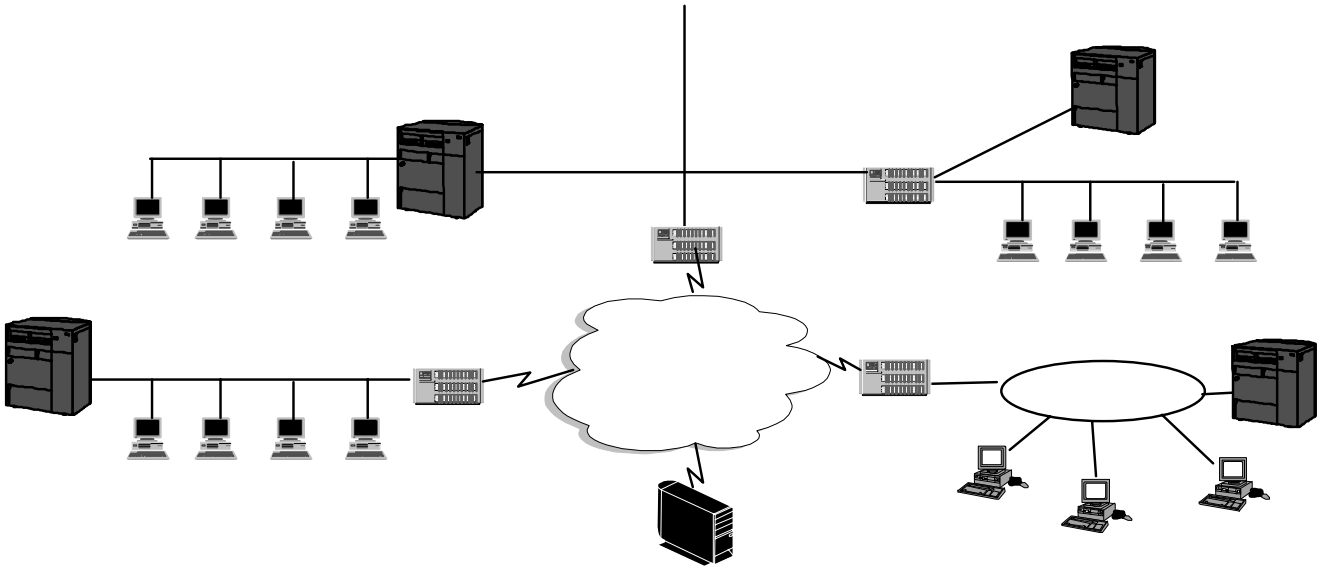
Link types - Wide Area Networks



Physical	Data Rates	Transport Protocols Supported
V.24 / EIA 232	64 Kbps 115.2 Kbps	Synchronous PPP, Bisync, SDLC, X.25 Asynchronous, including Async PPP
ITU V.35 or EIA-449/ITU V.36	2.048 Mbps 640 Kbps 64 Kbps	Synchronous PPP, Frame Relay, SDLC X.25 Bisync
ITU X.21	2.048 Mbps 640 Kbps	Synchronous PPP, Frame Relay, SDLC X.25
ISDN Basic	2-64 Kbps	IDLC, X.25
ISDN Primary	1.544 - 2.04 Mbps	IDLC, X.25

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Link types - Local Area Networks



Physical	Data Rates	Transport Protocols Supported
Token Ring	4, 16	TCP/IP, IPX, APPC / APPN / HPR
Ethernet	10, 100 Mbps	TCP/IP, IPX, APPC / APPN / HPR
FDDI / SDDI	100 Mbps	TCP/IP, IPX, APPC / APPN / HPR
ATM	25, 34, 155 Mbps	LAN Emulation : Ethernet Token Ring
Wireless	2 Mbps	TCP/IP, IPX, APPC / APPN / HPR
Twinax	1 , 2 Mbps	TCP/IP
Opticonnect	40 M Bytes/s	TCP/IP, APPC/APPN

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

TCP/IP Protocols, Servers and Services

TCP/IP Servers & Services

- GUI Configuration support
- Updated File Transfer Protocol (FTP) client & server
- Updated Simple Mail Transfer Protocol (SMTP)
- Post Office Protocol (POP) version 3
- IBM HTTP Server (HTTP)
- Web-based Administration server
- Network File System (NFS) client & server
- Domain Name Service (DNS) Server
- IP Printing to HP-compatible network printers
- Line printer daemon (LPD) server
- Line printer requester (LPR)
- 5250/HTML workstation gateway
- TELNET client & server
- REXEC client & server
- BOOTP Server
- Remote IPL TFTP Server
- REXEC client (Run Remote Command -RUNRMTCMD)
- New Dynamic Host Configuration Protocol (DHCP) Server
- New TELNET server SSL support
- New Internet Key Exchange (IKE) server
- Layer 2 Tunneling Protocol (L2TP) server (LNS)

Physical interfaces

- IBM token-ring LAN
- Ethernet LAN
- Ethernet 100Mb LAN
- Distributed data interface (DDI - fiber or stp)
- Frame relay
- Wireless (LAN)
- X.25 (PVC and SVC)
- X.25 over ISDN
- Integrated PC Server LAN
- Asynchronous support
- ATM
- Twinax

TCP/IP protocols supported

- Transmission control protocol (TCP)
- User datagram protocol (UDP)
- Internet protocol (IP)
- Simple network management protocol (SNMP)
- APPC over TCP/IP
- Internet protocol over SNA
- Network status (NETSTAT)
- Packet internet groper (PING)
- Internet control message protocol (ICMP)
- Address resolution protocol (ARP)
- Proxy address resolution protocol (Proxy ARP)
- Routing Information Protocol (RIP) ver 1 & 2
- Sockets application program interface (API)
- IP multilink load balancing
- Serial line internet protocol (SLIP)
- Point-to-point protocol (PPP)
- SOCKS proxy enablement
- New UDP multicast support
- New CORBA ORB (IIOP)
- IP Security (IPSec)
- New Internet Security Association Key Management Protocol (ISAKMP)
- Layer 2 Tunneling Protocol (L2TP)

A Complete set of Open Industry Standards

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 TCP/IP Standards Supported

768 - User Datagram Protocol
791 - Internet Protocol
792 - Internet Control Message Protocol
793 - Transmission Control Protocol
813 - Window and Acknowledgment Strategy in TCP
815 - IP Datagram Reassembly algorithms
816 - Fault Isolation and Recovery
821 - SMTP
822 - Standard for the format of ARPA internet text messages
826 - An Ethernet Address Resolution Protocol
854 - Telnet Protocol Specification
855 - Telnet Option Specifications
856 - TELNET BINARY TRANSMISSION
857 - TELNET ECHO OPTION
858 - TELNET SUPPRESS GO AHEAD OPTION
860 - TELNET TIMING MARK OPTION
879 - The TCP Maximum Segment Size and Related Topics
884 - TELNET TERMINAL TYPE OPTION
885 - TELNET END OF RECORD OPTION
894 - A Standard for the Transmission of IP Datagtams over Ethernet Networks
917 - Internet Subnets
919 - IP Broadcast Datagrams
922 - Broadcasting Internet Datagrams in the Presence of Subnets
950 - Internet Standard Subnetting Procedure
951 - BOOTP...
959 - File Transfer Protocol
974 - Mail Routing and the Domain System
1034 - Domain Names - Concepts and Facilities
1035 - Domain Names - Implementation and Specification
1042 - A Standard for the Transmission of IP Datagrams over IEEE 802 Networks
1144 - Compressing TCP/IP headers for low-speed serial links
1055 - Nonstandard for Transmission of IP Datagrams over Serial Lines: SLIP
1058 - RIP...
1091 - Telnet Terminal-Type Option
1112 - Host Extensions for IP Multicasting
1122 - Requirements for Internet Hosts - Communications Layers
1123 - Requirements for Internet Hosts - Application and Support
1155 - SNMP version 1...
1157 - SNMP version 1...
1179 - Line Printer Daemon Protocol
1205 - 5250 Telnet Interface
1213 - Management Information Base for Network Management of TCP/IP-Based Internets: MIB-II
1321 - The MD5 Message-Digest Algorithm
1332 - The PPP Internet Protocol Control Protocol (IPCP)
1334 - PPP Authentication Protocols
1349 - Type of Service in the Internet Protocol Suite
1542 - BOOTP Update...
1572 - Telnet Environment Option
1350 - TFTP...
1579 - Firewall-Friendly FTP
1600 - Internet Office Protocol Standards
1635 - How to use Anonymous FTP
1661 - The Point-to-Point Protocol (PPP)
1662 - PPP in HDLC-Like Framing
1721 - RIP..
1722 - RIP..
1723 - RIP..
1725 - POP3...
1782 - TFTP...
1783 - TFTP...
1784 - TFTP...
1877 - PPP Internet Protocol Control Protocol Extensions for Name Server Addresses
1994 - PPP Challenge Handshake Authentication Protocol (CHAP)
2045 - MIME...
2046 - MIME...
2047 - MIME...
2049 - MIME...
2131 - Dynamic Host Configuration Protocol
2132 - DHCP Options and BootP Vendor Extensions

And more with each release....

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Focus on What's New

New TCP/IP Features in OS/400

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

What's New for V4R2 TCP/IP?

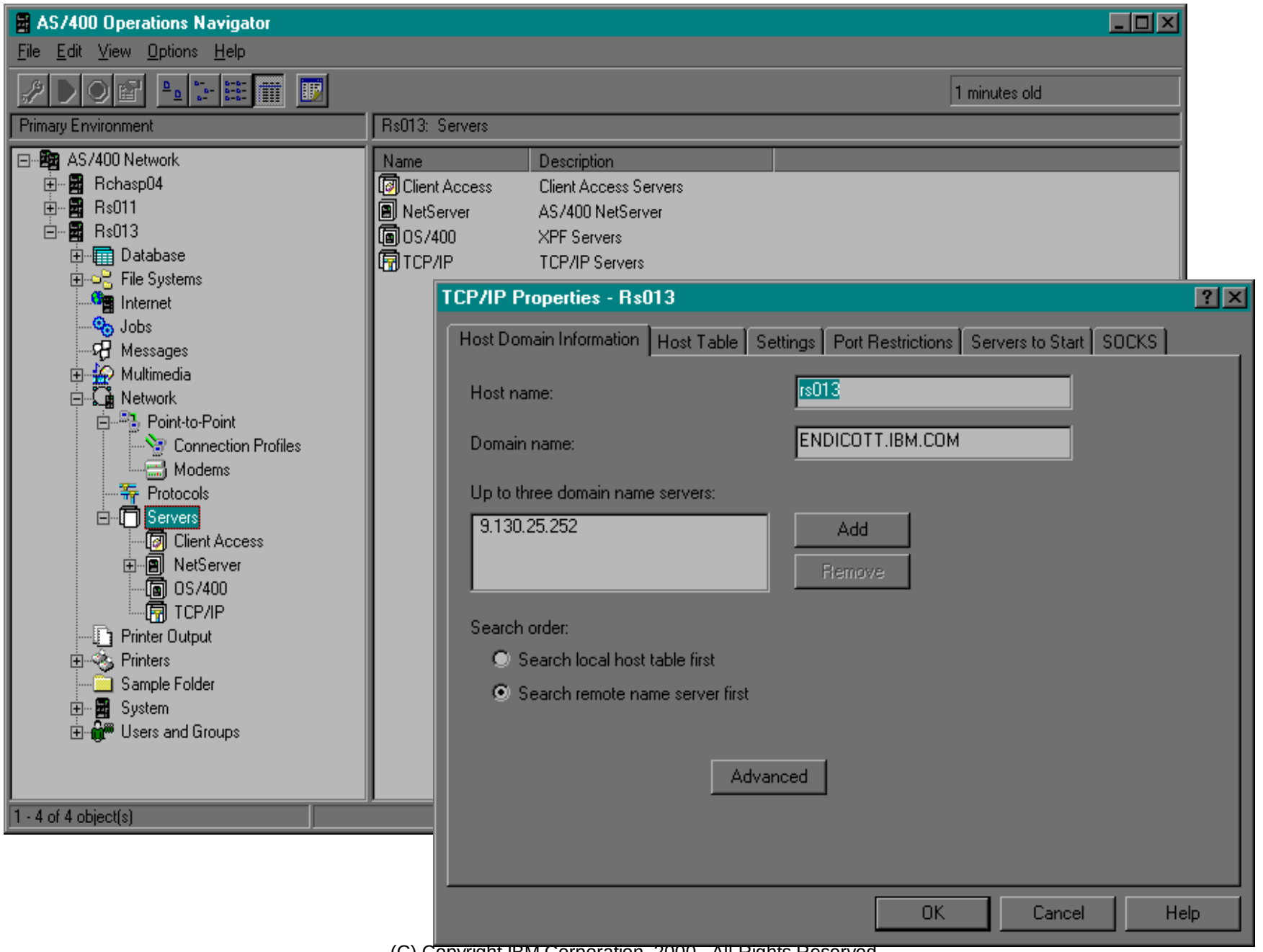
✓ *Create TCP/IP intranets of moderate complexity by simply cabling together AS/400 systems and clients*

✓ *Robust and Complete TCP/IP Server Suite comes with OS/400*

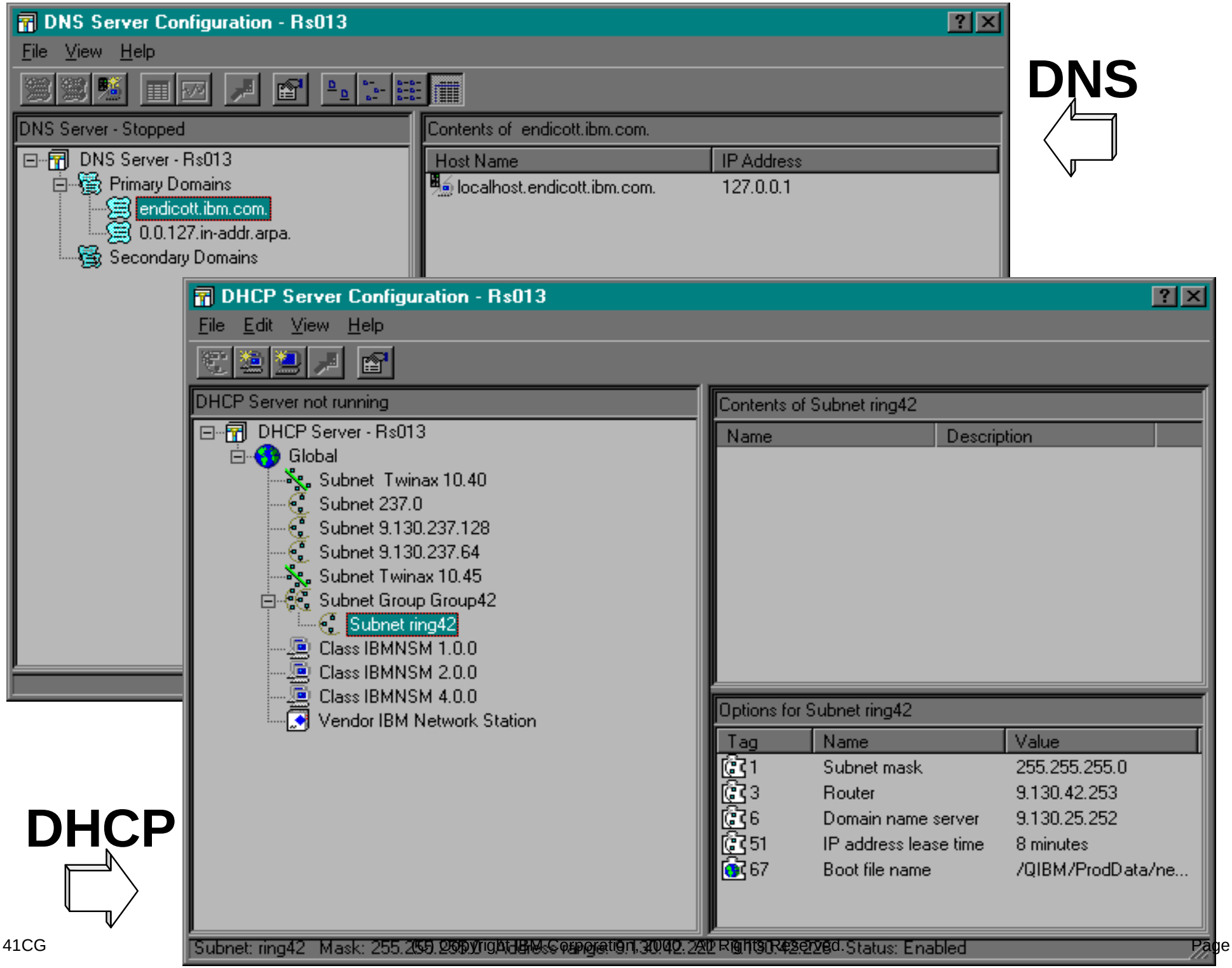
- Key TCP/IP servers now available natively on AS/400
  - ►DNS name server: naming service used by all TCP/IP appications
  - ►DHCP server for autoconfiguration of TCP/IP workstations
  - ►IMAP4 Mail Server and LDAP Directory Server via Native Domino
- Advanced Functions
  - ►TCP/IP Windows GUI Administration and new Configuration Wizard
  - ►Telnet 5250 Extensions for Printing, Device Name selection & more
  - ►OS/400 TCP/IP Clients now SOCKS enabled - Telnet, FTP, etc.
  - ►IP Multicast: reduces network traffic - sends single packet to multiple hosts
  - ►TCP/IP Outbound Multi-Link Load Balancing
- Robust WAN and Routing support
  - ►PPP for WAN links (analog, ISDN, 56k, T1, E1, etc)
  - ►RIPv2 with CIDR and added security for routing
  - ►Routing protocol on leased lines incl. frame relay
  - ►TCP/IP over Twinax and ATM (LAN-E)
  - ►TCP/IP Performance Improvements

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 Makes TCP/IP Easy



(C) Copyright IBM Corporation, 2000. All Rights Reserved.



(C) Copyright IBM Corporation 2000. All Rights Reserved.

Domain Name Service aka DNS

The Naming Service of the Internet and intranets

Starting in V4R2, DNS comes with AS/400 (OS/400 option)

DNS Server eliminates the need for duplicating host tables across all systems on your TCP/IP network

- host table to DNS migration command is included

Full implementation of the industry-standard DNS server

- Supports primary, secondary and caching roles
- Round-robin load balancing

Excellent GUI admininistration and configuration

- don’t need to do cryptic text editing of config files

NSLOOKUP included as an administrative aid

- English Only

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Dynamic Host Configuration Protocol aka DHCP

Central management and automation for configuring TCP/IP workstations

A standards-compliant DHCP server

- Support PCs, UNIX workstations, Thin Clients, ...

Migration from AS/400 BOOTP server to DHCP

- Superior management and function

Support for TCP/IP over Twinax interfaces

- Configuration automation for Twinax-attached IP devices

Includes a Built-in BOOTP/DHCP Relay server

- Enables centralized management in multi-subnet networks

Includes DHCP server exit points

- Can add custom security and auditing/reporting features

Configurable from the Operations Navigator

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

DHCP Exit Points

These 3 exit points are provided by the server:

- QIBM_QTOD_DHCP_REQ
  - Called when a packet is received
  - Gives read-only access to the packet
  - Used for process/discard decisions for the packet
- QIBM-QTOD-DHCP-ABND
  - Called when an IP address is assigned (bound) to a client
  - This is a read-only notification
- QIBM_QTOD_DHCP_ARLS
  - Called when an IP address is released
  - This is a read-only notification

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

DHCP Planning

How Many DHCP Servers do you need?

- DHCP broadcast messages do not cross subnets
- BOOTP/DHCP Relay agents can link subnets
- Consider redundancy and reliability

Do you already have BOOTP servers?

- BOOTP and DHCP servers can not both be running on any individual system
- Do you replace them with DHCP servers or change them to BOOTP Relay Agents?

Do you have hosts with special requirements?

- A permanent lease, a specific IP address
- Specific configuration parameters
- Manually defined workstations

What is a reasonable lease time?

- Lease time can affect your network performance

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

New for V4R2: TELNET 5250 extensions

New security and automation enablement has been added to the AS/400 Telnet server

Printer Passthru support

- support for hundreds of PC-attached printers
- two new AS/400 terminal types (IBM-3812-1 and IBM-5553-B01) and protocol extensions which enable a client to dynamically create or select a virtual printer device through enhanced negotiation

Virtual Device Selection **by the attaching client (or a registered TELNET server exit program)**

- can do more traditional job-routing to preferred subsystems and associated work management tuning
- with Virtual Device selection, preferred code page, character set, and keyboard attributes can be established on a per session basis, thereby offering greater flexibility in national language support

Registered TELNET server exits **- for both session initialization and session termination**

- enables addition of custom security or work management features
- can be used to provide some of these new features without upgrading TELNET client emulator software,i.e. existing clients may be able to immediately benefit

Automatic sign-on **(optional bypass of the sign-on procedure)**

- enabled for TELNET display sessions which have specific settings for the QRMTSIGN system value

TELNET Session disconnect/reconnect **(QDEVRCYACN) is enabled**

- for display sessions that use "consciously selected" device names.

Support for system inactivity timer **- QINACTITV (INACTive Interactive job Time-out Value)**

- specifies when the system takes action on inactive interactive jobs
- applies to both TELNET and Virtual Terminal API Connected Display sessions

(C) Copyright IBM Corporation 2000. All Rights Reserved

Terminal Emulation over TCP/IP

Telnet 5250 Extensions have been published as IETF draft:

- ftp://ftp.ietf.org/internet-drafts/draft-murphy-tn5250e-00.txt

Requires Updates to your client emulation software

- Client Access V3R1M**3** for Win 95 and Win/NT(5763-XD1) includes Printer Emulation and Device ID support
  - Bypass Signon Support (AutoLogon) support will be in the next Service Pack to V3R1M3. Available now at:
    http://ftp.software.ibm.com/as400/products/clientaccess/win32/v3r1m3/file/bypass
- IBM Personal Communications (PCOMM)will add 5250 Printer Session and Workstation ID in a CSD targeted for late 1998
- For availability of new function for non-IBM emulators check with your vendor

5250E will be available for OS/400 V4R1, V3R7, V3R2 as well

- Information APAR II10918 will be updated with the necessary PTFs as soon as they are available

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Firewall Enablement

Socks Clients

- All IBM-provided Sockets client applications are Socks-enabled
  - Telnet, FTP, LPR, REXEC (RUNRMTCMD)

E-mail Exchange

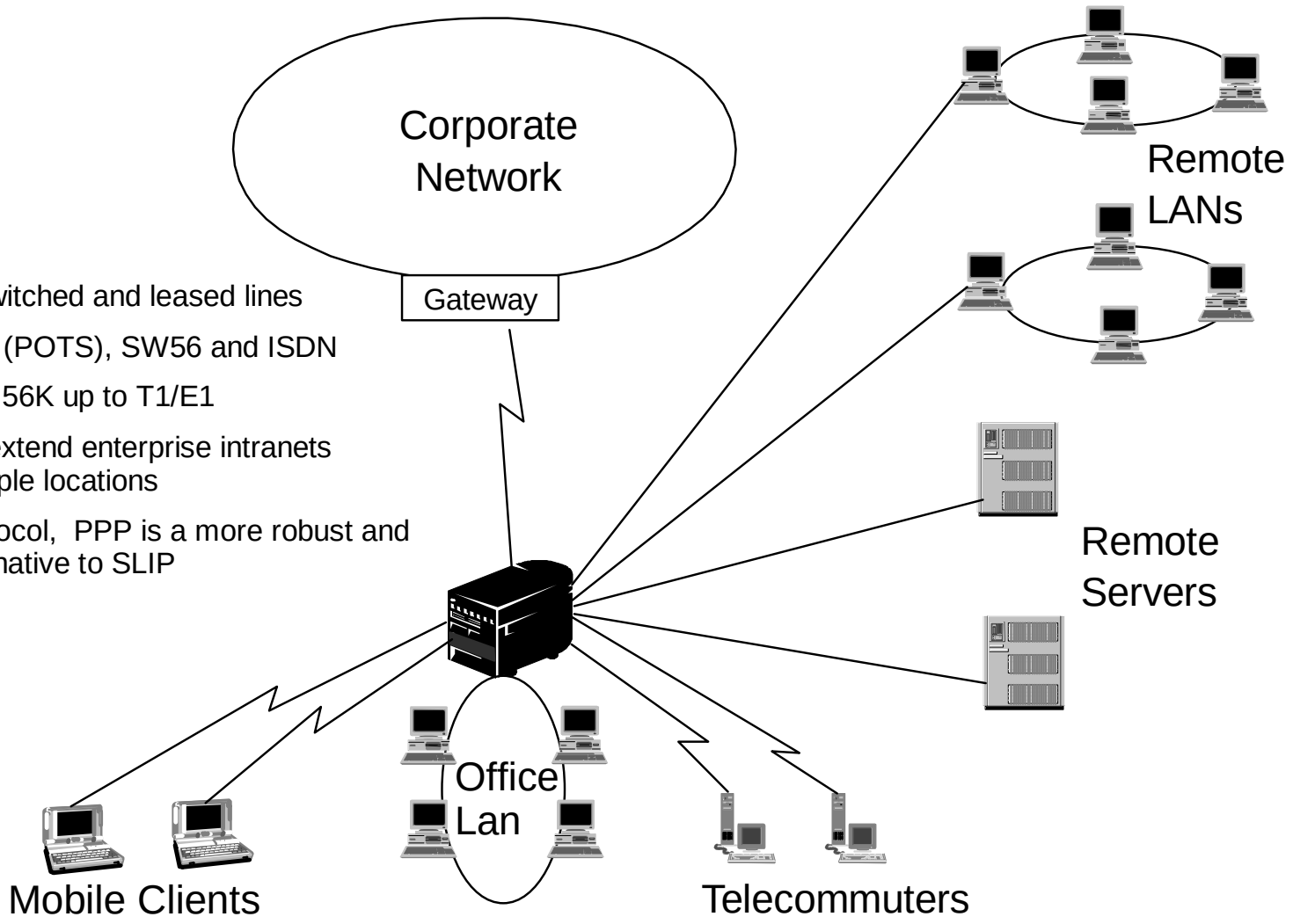
- Option to route all non-local outbound mail to a firewall
- Mail forwarding capabilities for setting up an AS/400 to receive inbound mail from a firewall and distribute it appropriately

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 TCP/IP Point to Point Protocol (PPP)

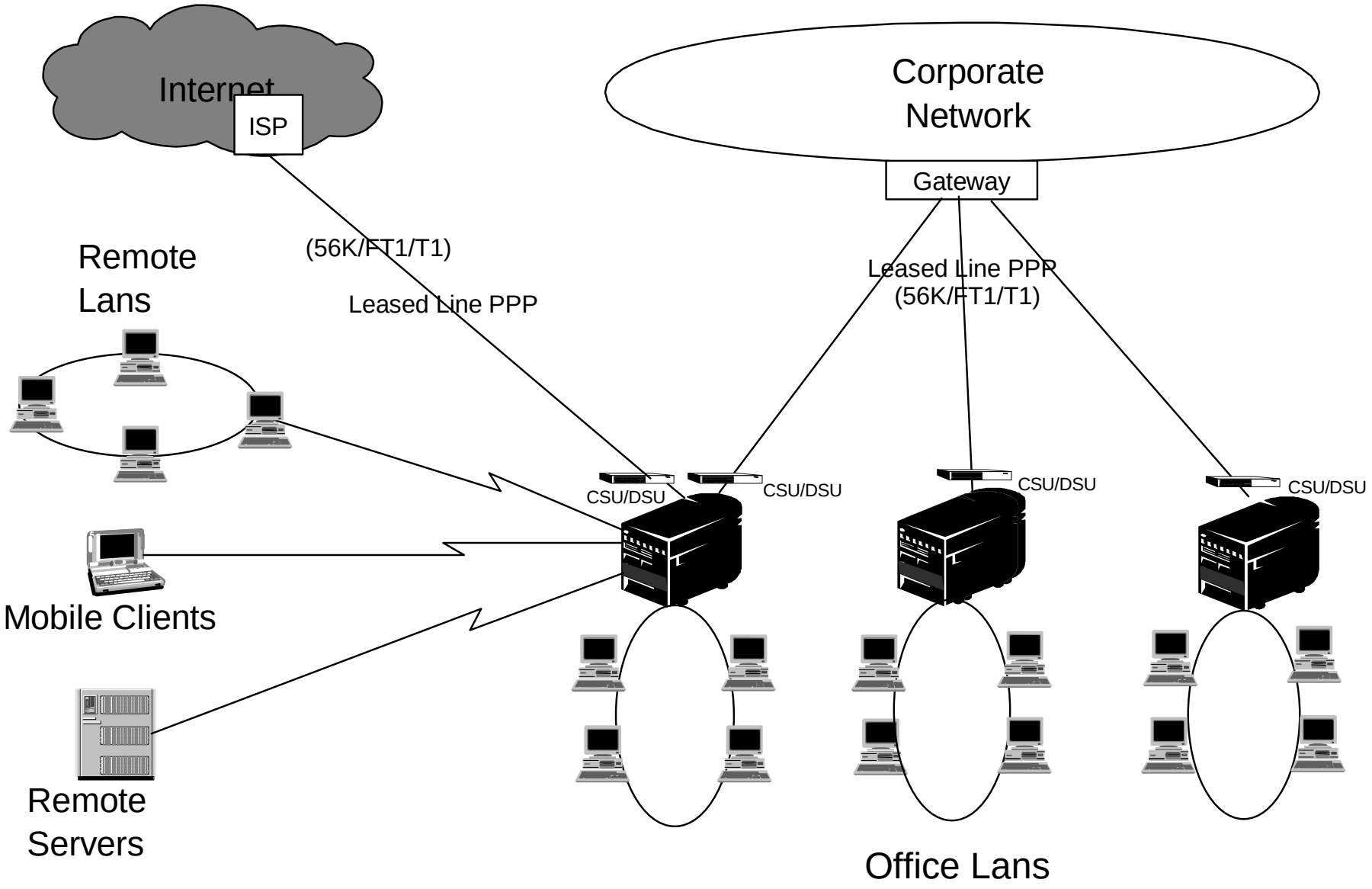
The open protocol for wide area network TCP/IP connectivity

- supports both switched and leased lines
  - analog (POTS), SW56 and ISDN
  - leased 56K up to T1/E1
- can be used to extend enterprise intranets across multiple locations
- as a dial-up protocol, PPP is a more robust and secure alternative to SLIP



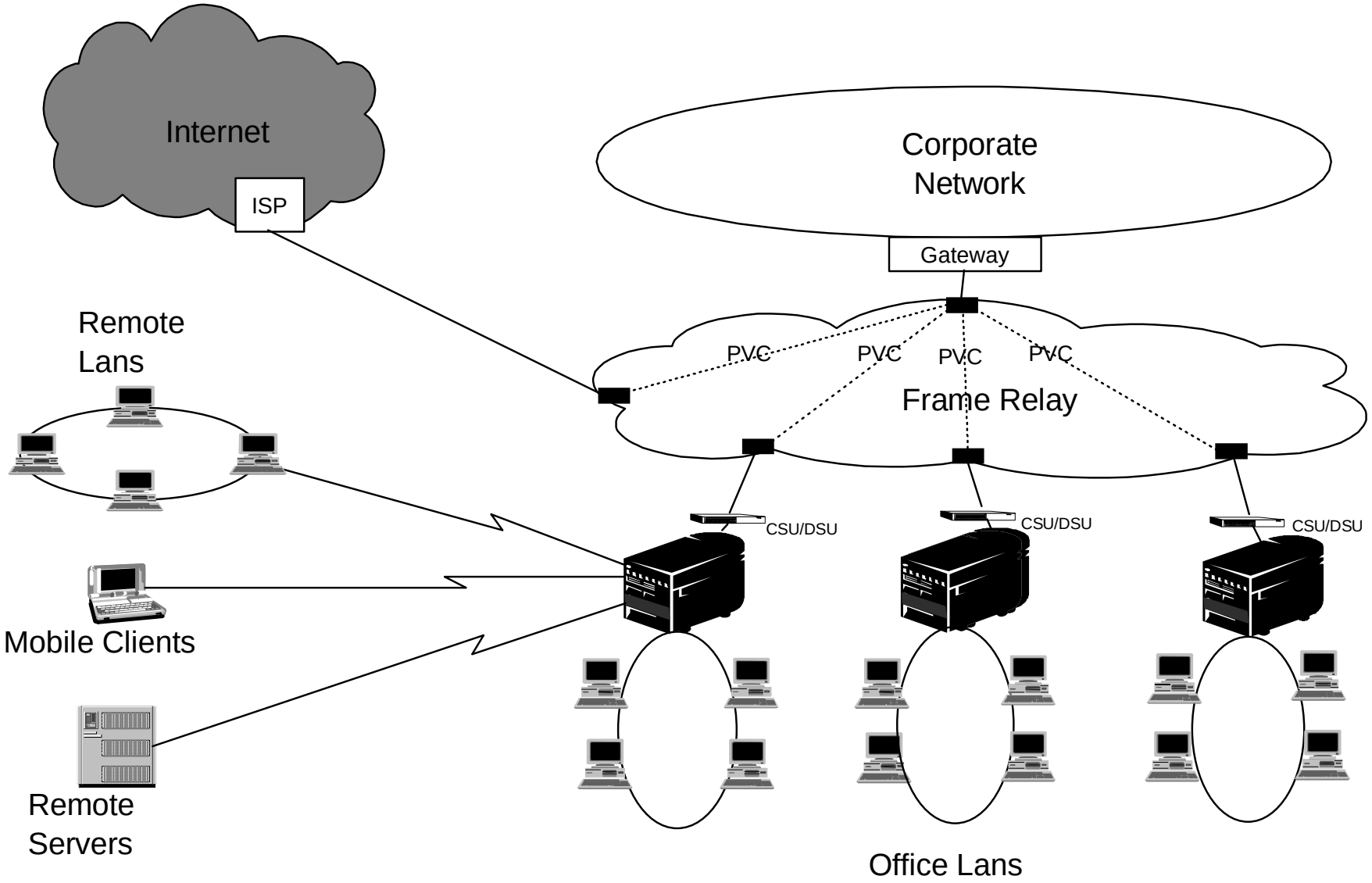
(C) Copyright IBM Corporation, 2000. All Rights Reserved.

TCP/IP PPP Dedicated WAN



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

TCP/IP Frame Relay based WAN



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 PPP Support

Hardware Requirements

- 2699 Two line WAN IOA
- 2720 PCI WAN/Twinaxial IOA
- 2721 PCI Two-line WAN IOA

Interfaces Supported

- RS232
- X.21
- V.35
- V.36 (RS-449)

PPP line types supported

- Asynchronous
- Synchronous
- Switched
- Nonswitched

Support of ISDN Terminal Adapters

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Built-in TCP/IP Routing (RouteD)
RIP version 1

First available in V4R1

Simplifies network configuration and administration when for nontrivial networks

- allows routers in the network to automatically update AS/400 route table
- greatly simplifies configuration tasks when AS/400 is in networks with multiple routers
- improves AS/400 ability to respond to changing network conditions
  - AS/400 chooses "best" route to a destination based on current network status

Optionally, AS/400 may also send routing updates

- useful if the AS/400 is serving as a router in the network
- must use **CHGRTDA** command to enable (default is to not send routing information)

Implements Routing Information Protocol (RIP)

- UDP-based protocol
- routers broadcast known routes on a periodic basis
- route information includes "distance" to destination
  - local route table is updated only if a route is received which is "better" than the currently known route

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

RouteD Configuration

Uses configuration directives to define:

- information for initializing route table
  - default routes
  - destinations reached by routers which do not exchange routing information
  - destinations reachable via external gateways
  - entries for these addresses are not added to IP routing table
  - prevents processing overhead for changes outside internal network
- interface options
  - define how RouteD processes networks to which the AS/400 is physically connected
  - used to "filter" RIP requests received from or sent to an interface

Directives are "free form" text

- entered and edited using **WRKRTDCFG** command
- entries checked for validity, invalid entries highlighted

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

V4R2 TCP/IP Routing Extensions

Routing Information Protocol - Version 2 (RIPv2)

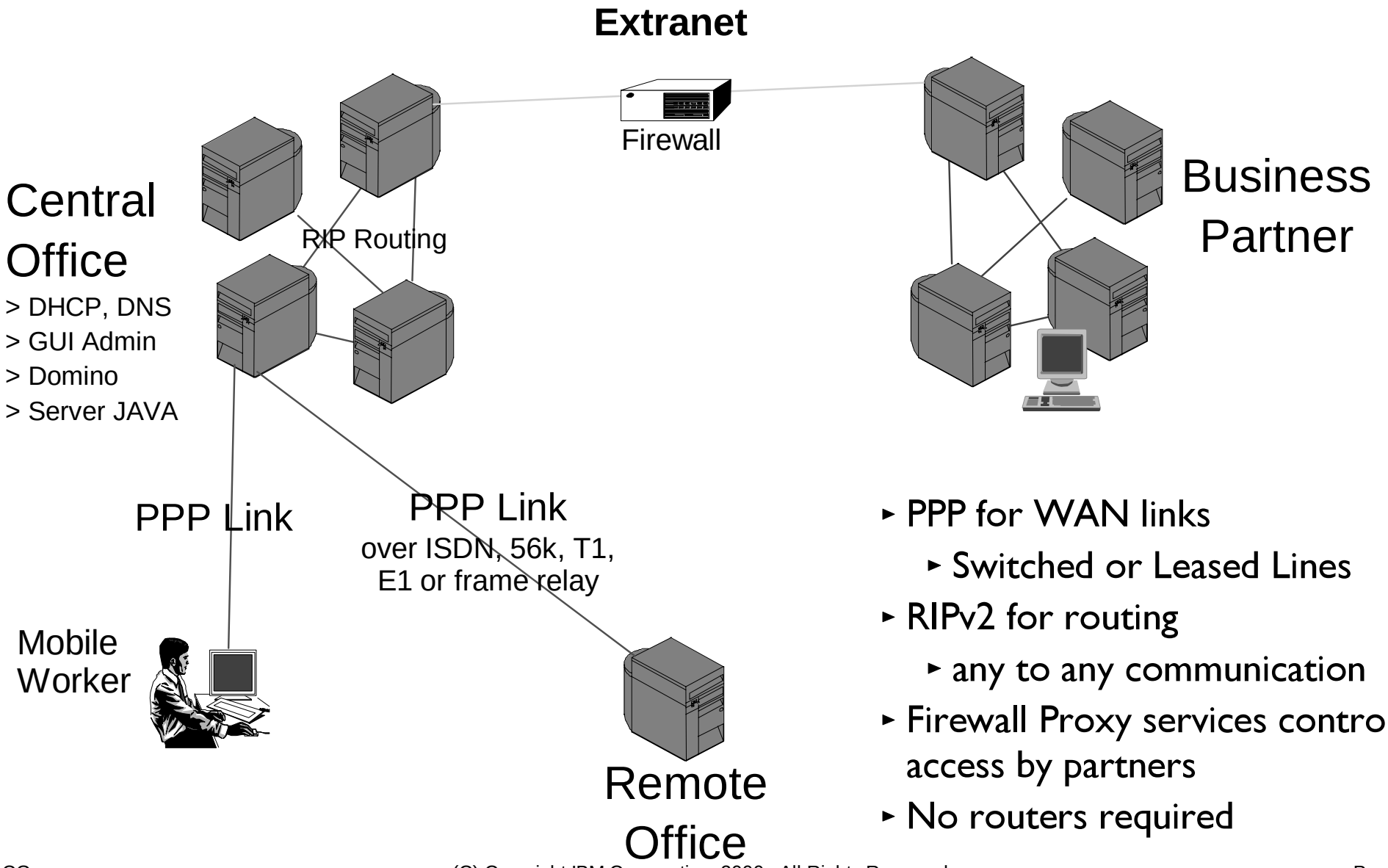
- **Support for subnet aggregation**
  - **Classless Interdomain Routing (CIDR)**
- **Enhanced security**
- **Capability to run routing protocol over WAN links**

Graphical Configuration via Operations Navigator

Automatically migrates existing routing configuration

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

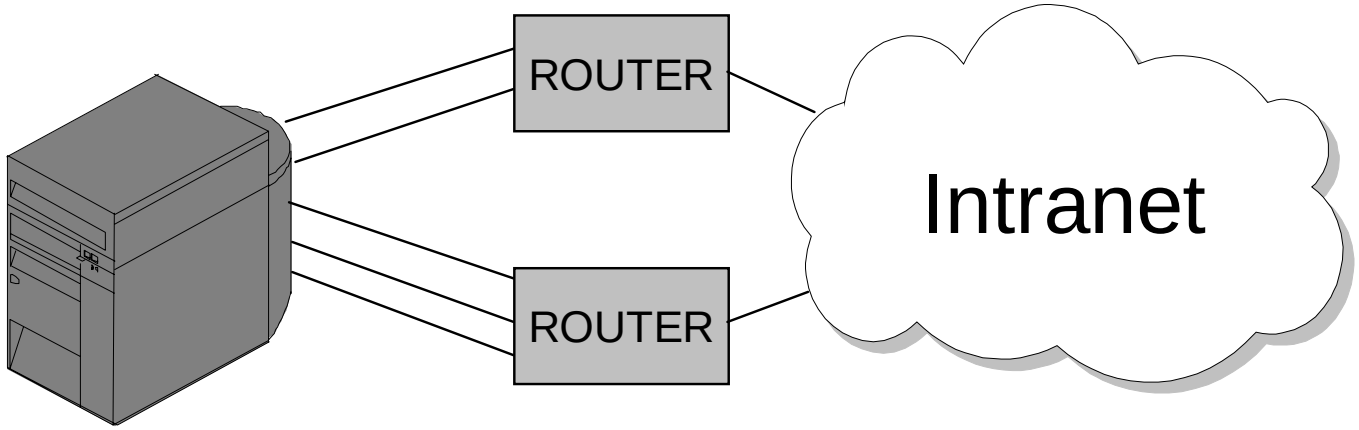
AS/400 Integrated Intranet Solutions



- PPP for WAN links
  - Switched or Leased Lines
- RIPv2 for routing
  - any to any communication
- Firewall Proxy services control access by partners
- No routers required

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Integrated IP Network Load Balancing for Scalability and Reliability



High-volume
e-business server

Multiple redundant paths from server to the network:

- Extendable horizontal bandwidth growth
- High Availability tolerance of link or router failures

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Integrated IP Network Load Balancing for Scalability and Reliability...

Two new parameters on the ADDTCPRTE command:

- Preferred Binding Interface (BINDIFC)
- Duplicate route priority (DUPRTEPTY)

Prior to V4R2, static routes were internally bound to the first acceptable interface found

- if you had multiple interfaces to the same network, and multiple routes were defined to gateways on the network, all of these routes would still get bound to the same interface
  - Thus all traffic would still be directed out the same interface.

With V4R2, you can explicitly specify to which interface an interface should be bound.

- So you can bind one route to the first interface and a second route to a second interface
- Moreover, if you set the priority on both routes to a value higher than the default of 5, the two routes/interfaces will be selected in a round robin fashion.
  - routes are "selected" when a connection is established.
  - round-robin'ing is done on a connection basis rather than an individual packet basis.

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

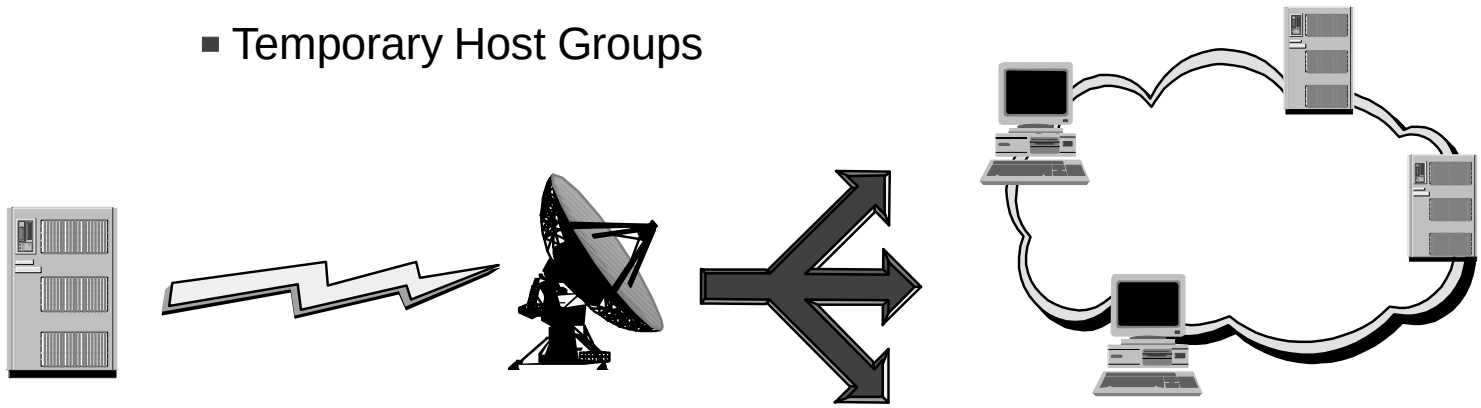
IP Multicast Application Enablement

One-to-many transmission from a single system to a host group

Must be a UDP (connection-less) application

Host groups:

- Set of zero or more hosts identified by a single Class D IP destination address
- Group address range from 224.0.0.0 to 239.255.255.255
- Hosts may join and leave a group at any time
- Permanent Host Groups
  - Group address assigned by Internet Assigned Number Authority (IANA)
- Temporary Host Groups



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Multicast Support on AS/400

Full Level 2 support

Internet Group Management Protocol (IGMP)

- Used by IP hosts to report their group host membership
- IGMP messages are used to keep the group information up-to-date

Link layer needs to:

- Map the IP destination address to a multicast MAC address (Ethernet/FDDI, Tokenring)
- Filtering mechanism

Multicast does not map well with all link layers such as X.25 and Twinax

The AS/400 cannot act as a multicast capable router

Different IOPs provide different level of multicast support

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Multicast Configuration on AS/400

Work with TCP Network Status (WRKTCPSTS or NETSTAT)

- Displays the Multicast group associated with each interface
  - Use list option 14= Display multicast groups

Verify TCP Connection (VFYTCPCNN or PING)

- New parameter is *IP time to live* (IPTTL)
- Add TCP Route (ADDTCPRTE) command has several new parameters:
  - - *Preferred binding interface* (BINDIFC)
  - - *Route metric* (METRIC)
  - - *Route destination* (REDST)
  - - *Duplicate route priority* (DUPRTEPTY)
  - and a new special value:
  - - Default Multicast (*DFTMCAST) for the *Route Destination* (RTEDEST) parameter

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 TCP/IP Graphical Administration

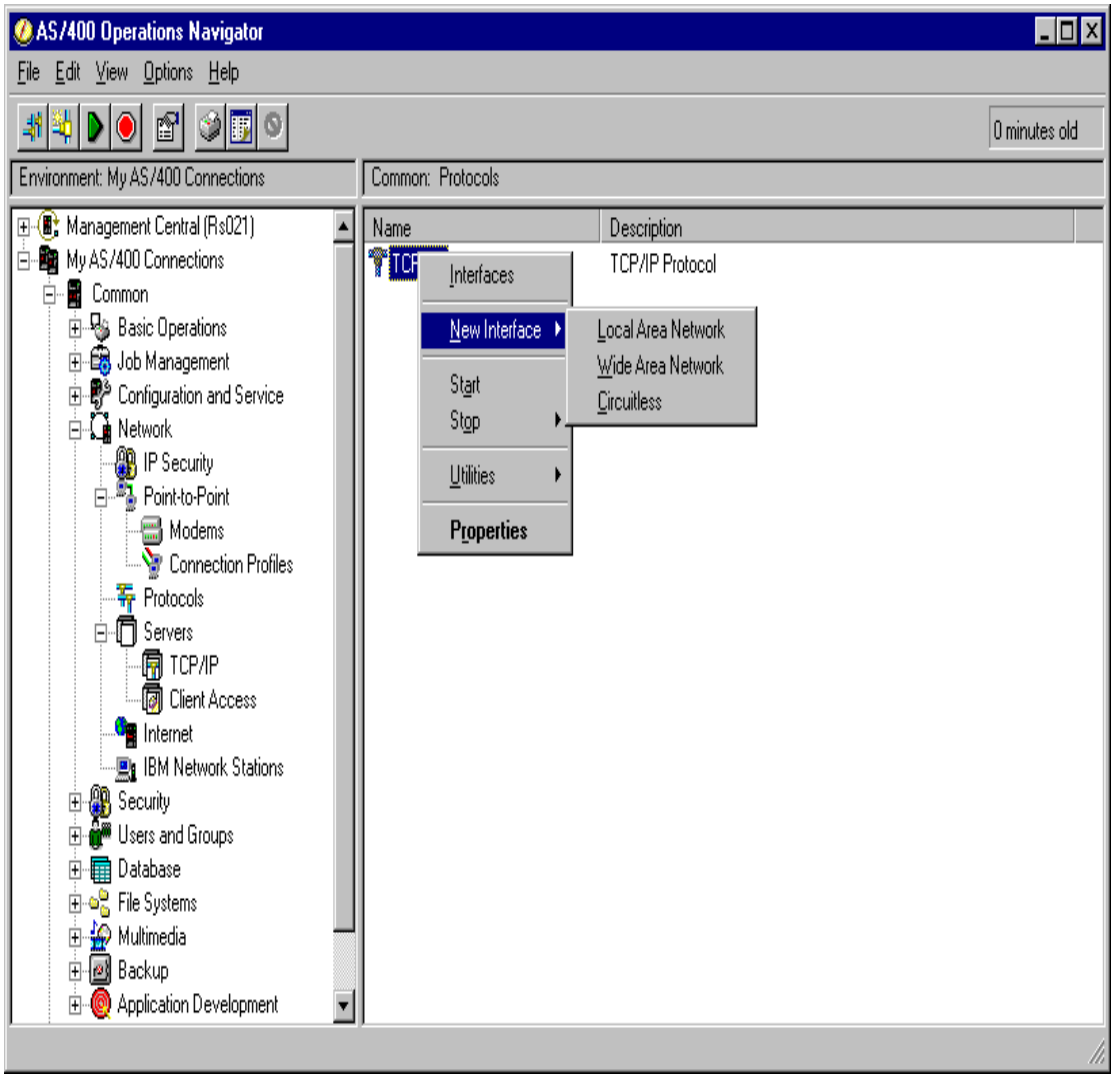
Easy to implement and manage TCP/IP based networks using the AS/400 Operations Navigator TCP/IP graphical user interface component and wizards

Extending Simplicity to TCP/IP administration
in support of e-business

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

TCP/IP setup wizards supplied for easy setup

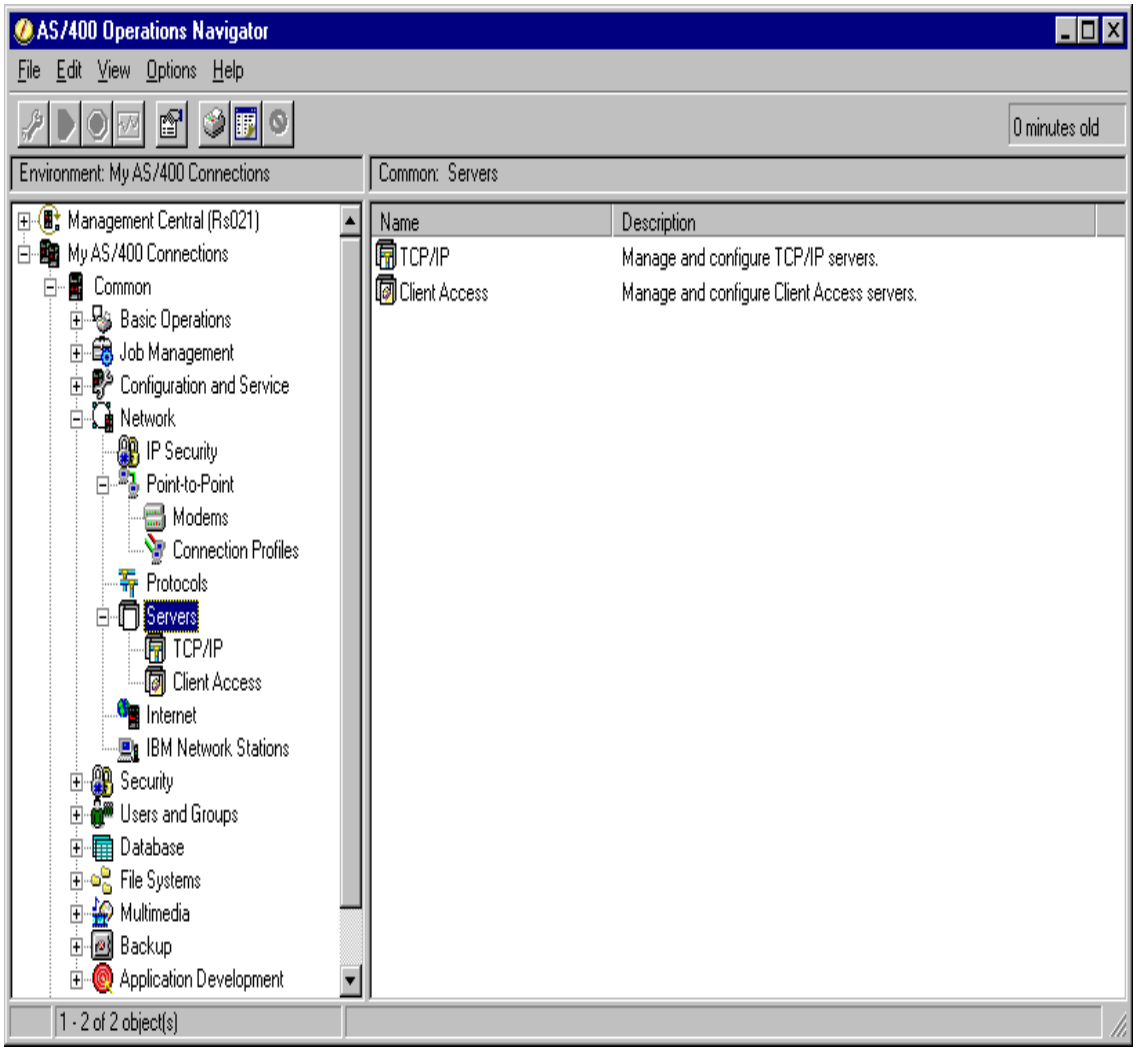
- LAN Wizards
  - Ethernet
  - Token-ring
  - Distributed Data Interface (DDI)
  - Wireless
  - Opticonnect
- WAN Wizards
  - Bridged Ethernet, Token-ring, DDI
  - Non-bridged direct
- Circuitless
  - TCP/IP in-bound load balancing
  - Frame relay multi-access
  - Unnumbered networks
- VPN wizards (Scenario based)
  - Mobile/Remote user
  - Branch office
  - Extranet
- DHCP wizard
  - Initial configuration and subnets
- DNS wizard
  - Initial configuration and domains



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 Servers administration

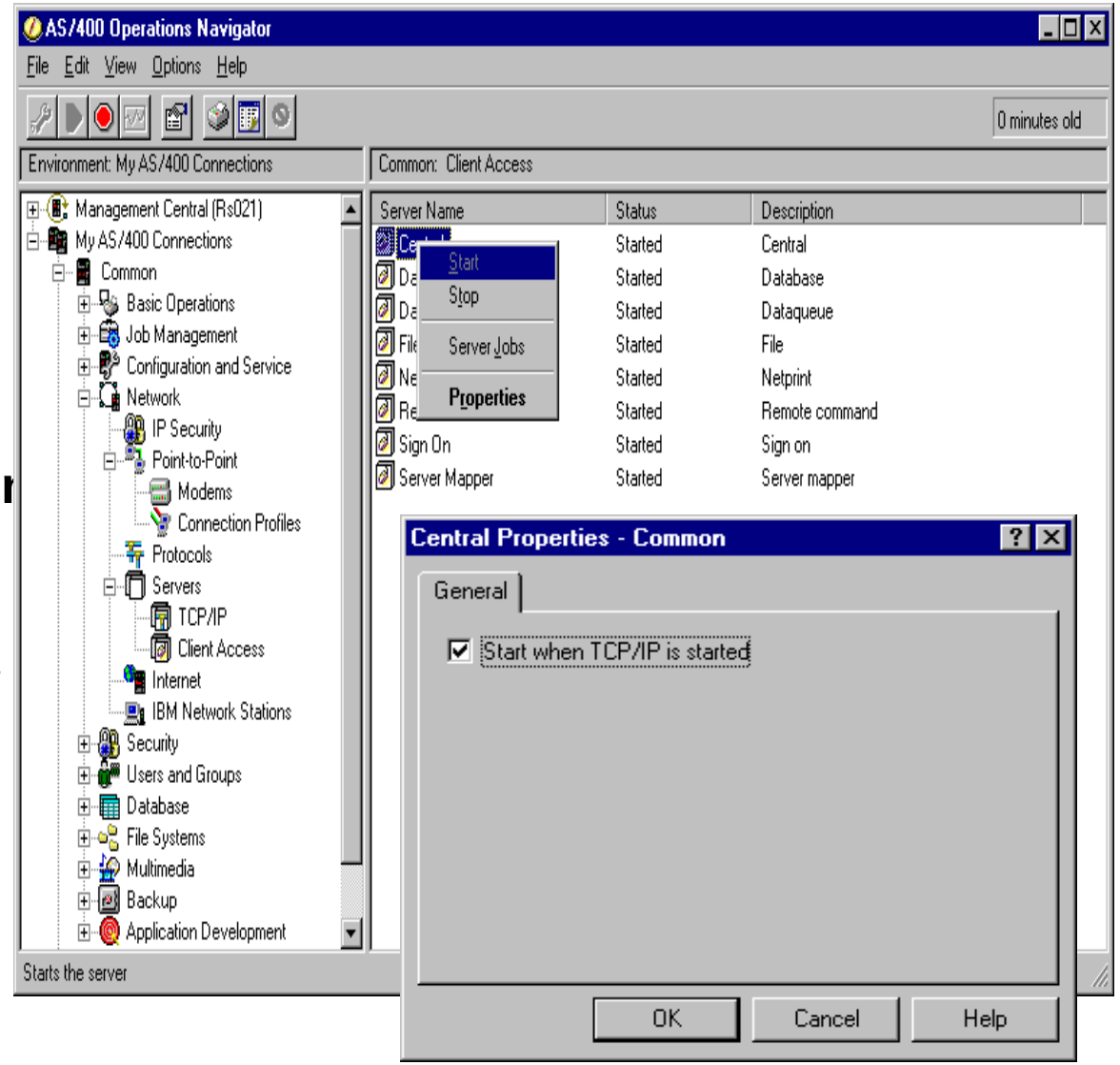
- Management of servers that support being run over TCP/IP consolidated into a single place
- Tasks:
  - Start/Stop/Properties
  - Server status
- AS/400 automatically searched for installed base options and LPPs



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 Servers administration - Client Access folder

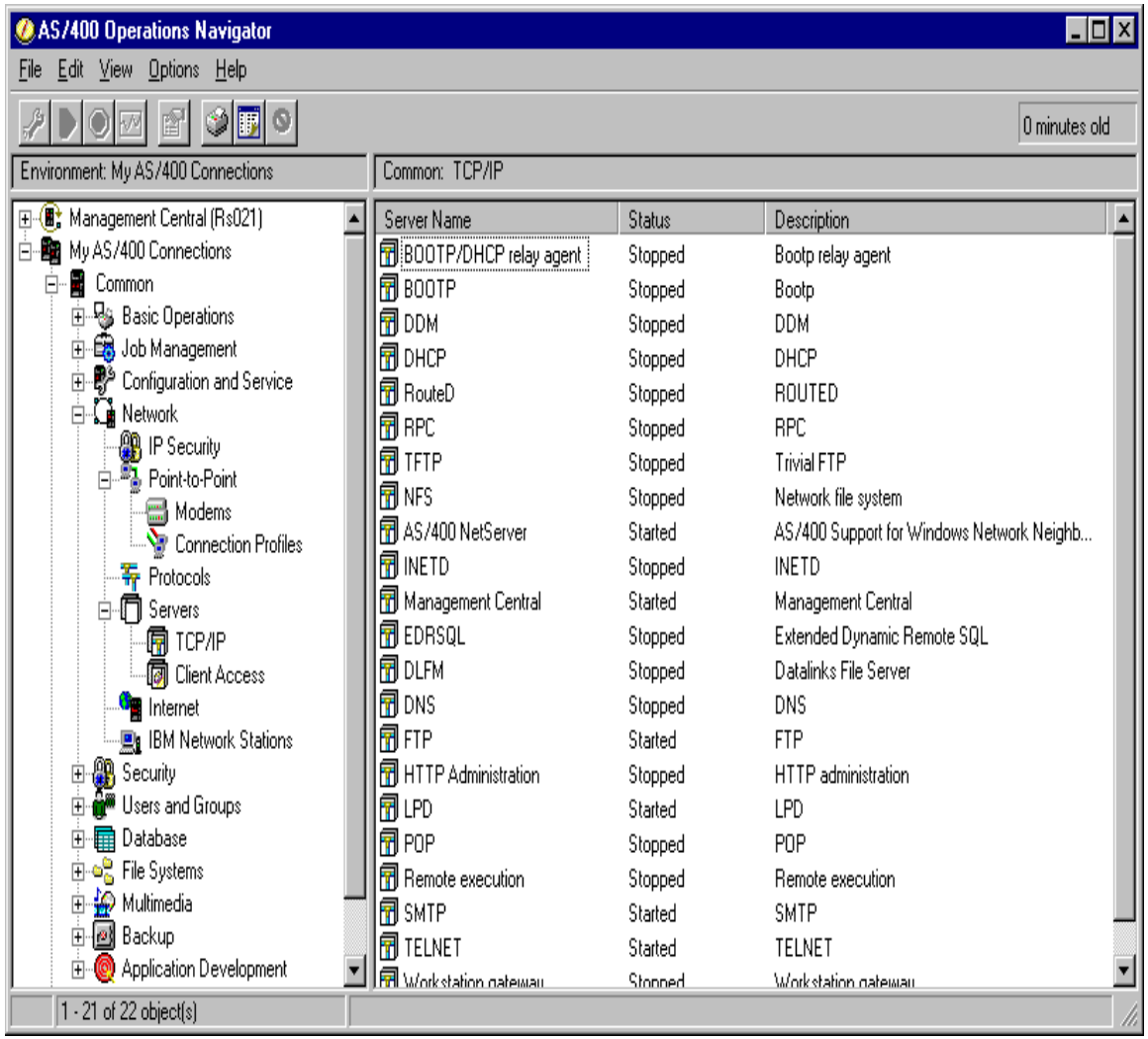
- Contains list and status of installed Client Access host servers
- Start/Stop tasks greyed out appropriately based on status
- Client Access servers can be configured to "Start when TCP/IP is started"



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 Servers administration - TCP/IP folder

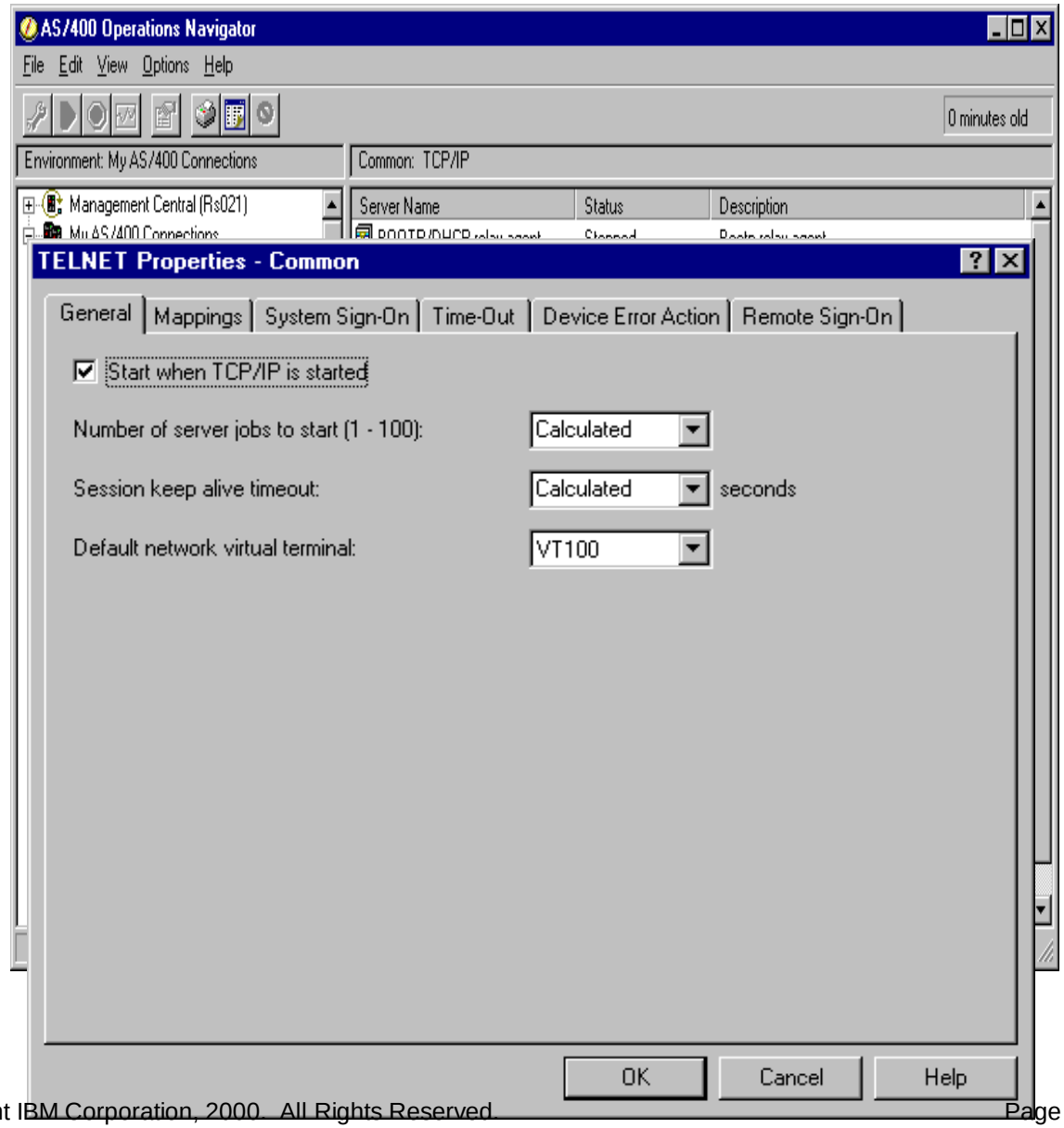
- Contains list and status of installed base servers and options as well as LPPs
- Start/Stop Tasks greyed out appropriately based on status
  - Configuration or Properties task available
- New for V4R2 servers
  - Relay agent
  - DHCP
  - DNS
  - Dynamic Routing
  - RPC
- New for V4R3
  - NFS
  - DCE
  - Directory (LDAP)
  - Network Stations Login Daemon
- New for V4R4
  - Management Central
  - INETD
  - on-Demand
  - Data Links File Management
  - Extended Dynamic Remote SQL



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 Servers administration - TCP/IP folder

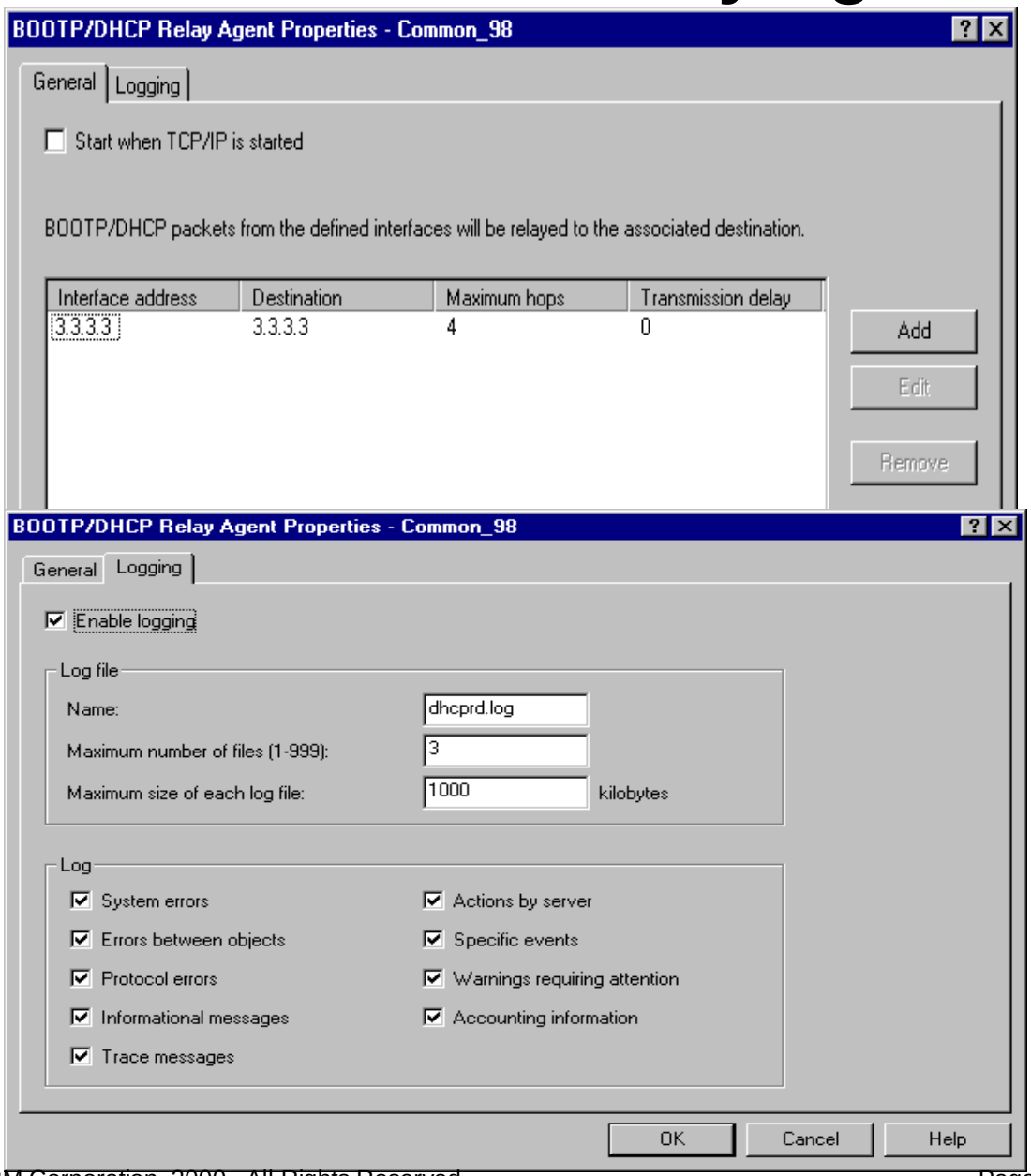
- Contains list and status of installed base TCP/IP applications (TC1) and LPPs
- Start/Stop tasks greyed out appropriately based on status
- All TCP/IP applications have properties
- Work with server jobs available for servers
- Start/Stop for HTTP administration server to allow Internet Connection Server administration (in Internet folder)



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

New V4R2 servers - BOOTP/DHCP Relay Agent

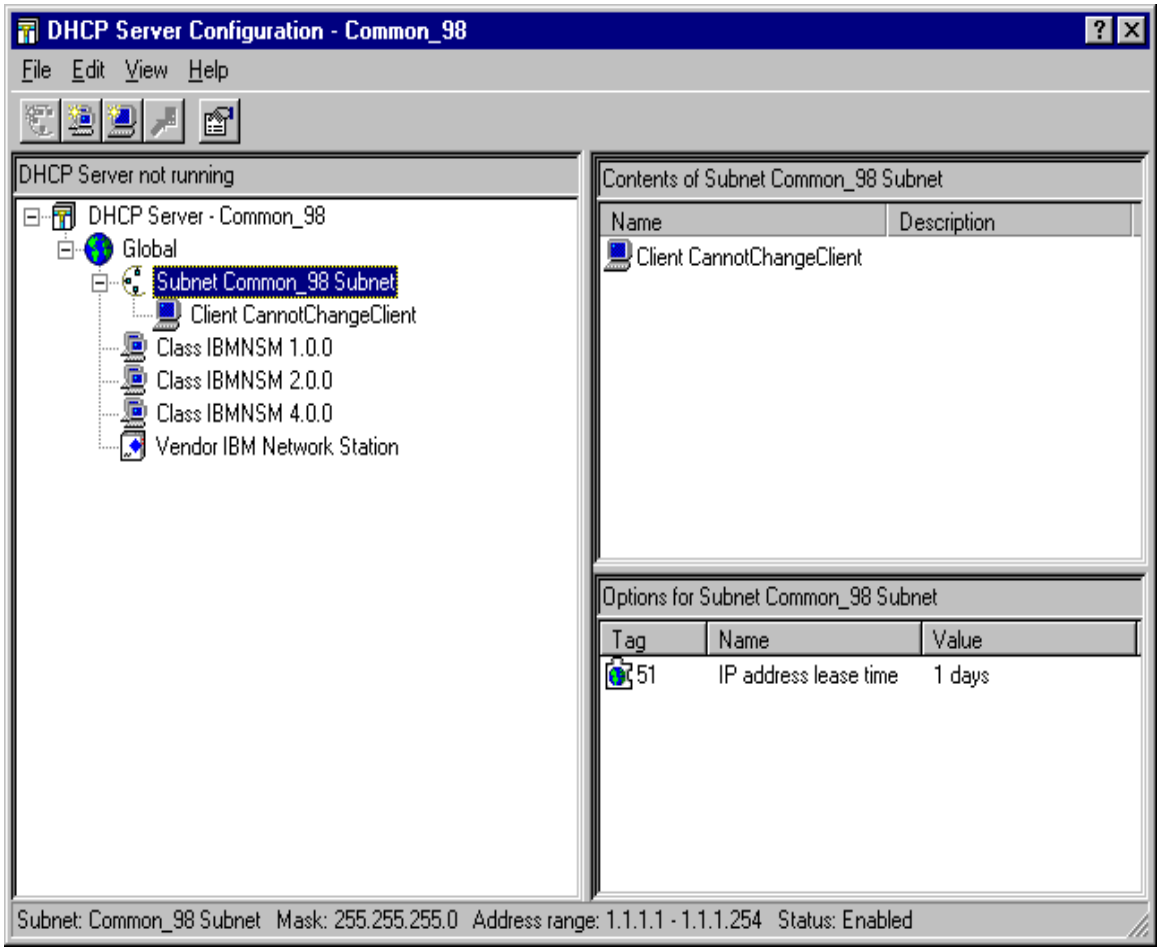
- Relay Agent part of base V4R2 OS/400
- Supports BOOTP and DHCP packets
- Allow binding to multiple TCP/IP interfaces for packet forwarding
- Supports being started when TCP/IP is started



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

New V4R2 servers - DHCP

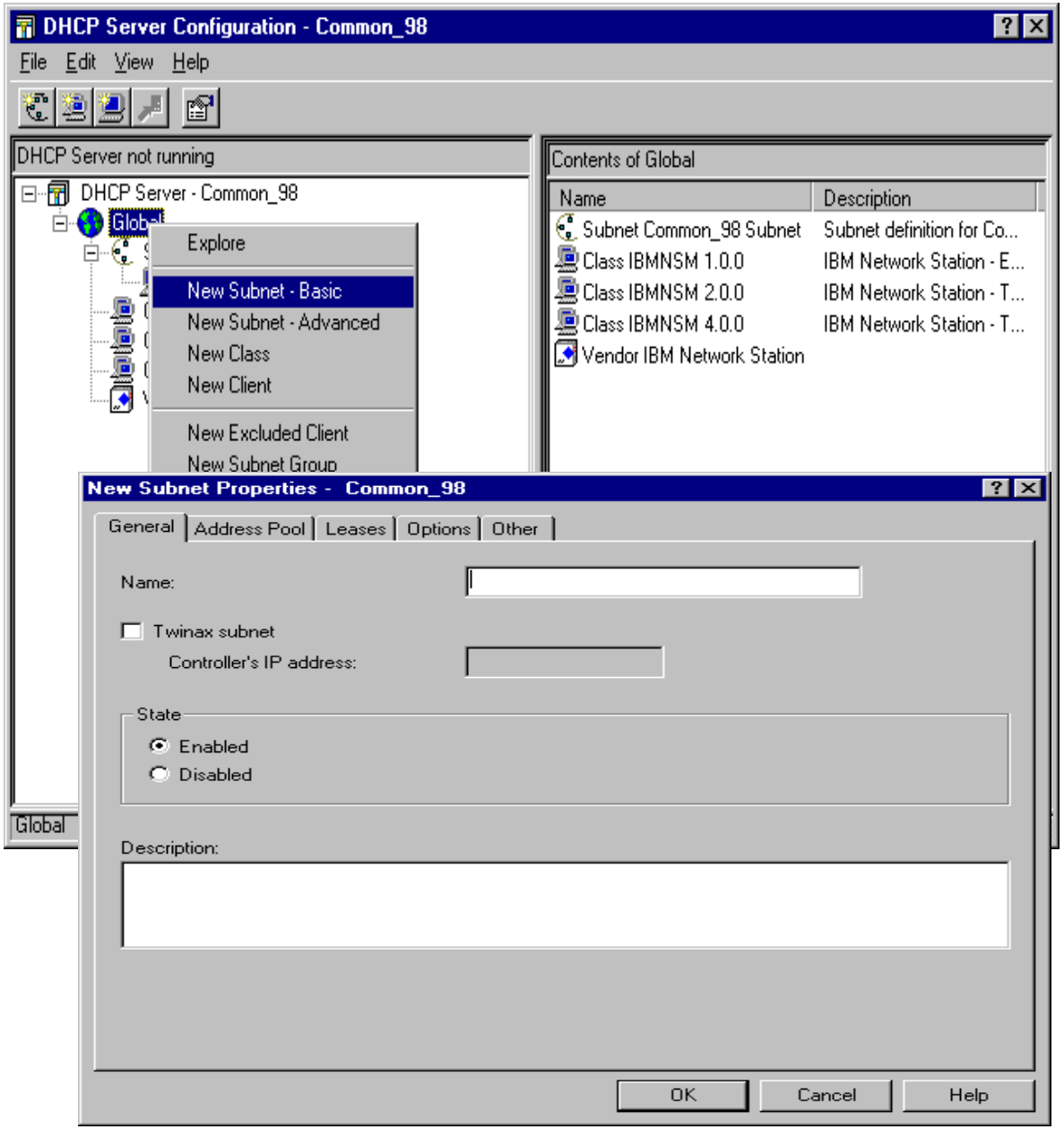
- DHCP part of base V4R2 OS/400
- Migration of BOOTP client information supported, if necessary
- Intuitive displaying of scoped DHCP options
- Subnet, classes, and clients being served as well as their options are presented in one window
- Subnet, classes, client, or option views supported for quick and easy management



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

New V4R2 servers - DHCP

- Wizards supplied to:
  - Simplify initial setup
    - Includes ability to migrate BOOTP information
    - Setup subnets during initial configuration
  - Simplify New subnets
    - Includes support for Twinax based subnets and setup of IBM Network Stations
  - Advanced subnet creation also supported



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Native TCP/IP Connectivity over Twinax

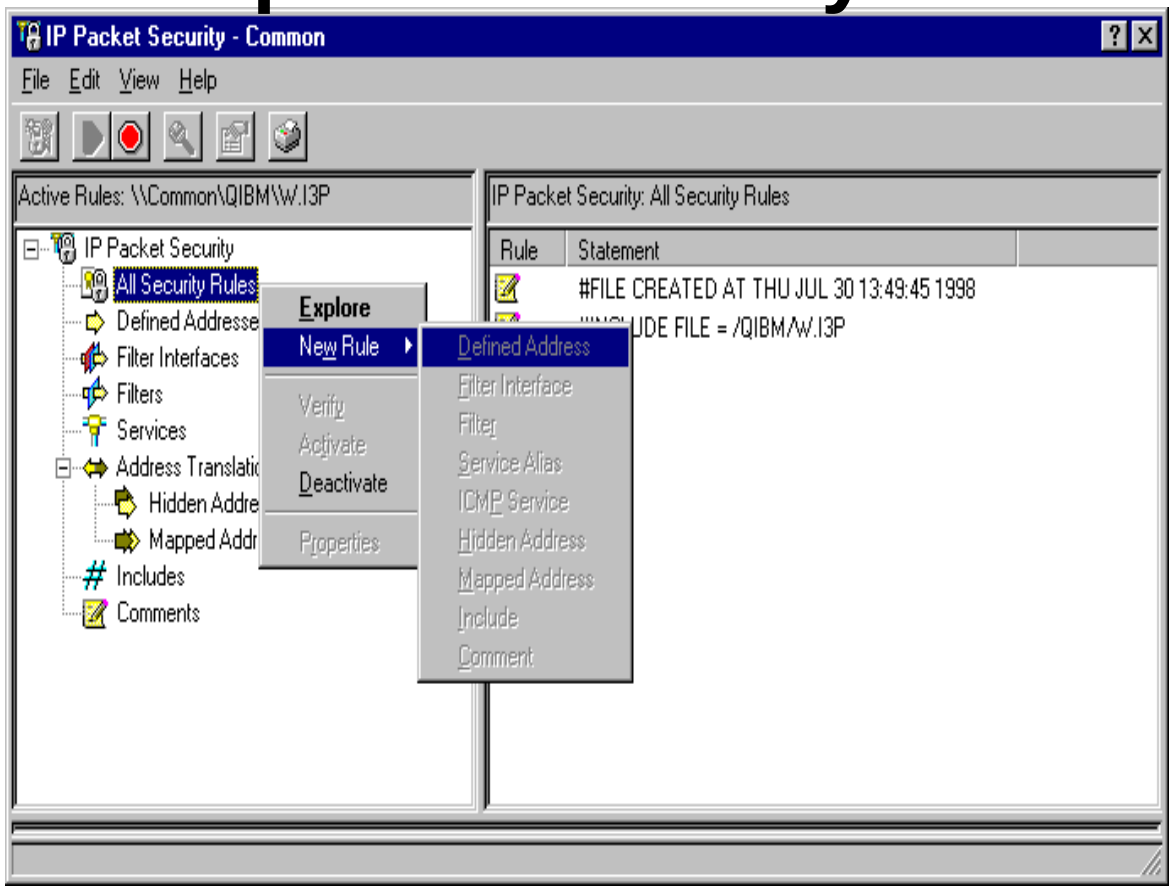
IBM 5250 Express PC Adapters for Twinax

- For latest information: **http:// www.networking.ibm.com/5250**
- On the AS/400: OS/400 V4R2 with the latest PTFs
- On the PC:
  - Microsoft Windows 95 or Microsoft Windows/NT 4.0 or later
  - IBM 5250 Express ISA, PCI or PC Card must be installed in the PC
    Note: some older IBM 5250 Emulation Adapters are also supported, but will have slower performance than the 5250 Express Adapters.
- 5250 Express Adapters also support the 5250 Express Data Stream
  - requires a RISC AS/400 with a PCI Twinaxial WSC
  - increases throughput by 4X over the traditional 5250 data stream
- IP/Twinax supports up to 1,525m (5,000ft) of twinax cabling or up to 1,220m of UTP cat 5 cabling directly connected to the AS/400 (ethernet needs hubs/repeaters every 100m or so).
- The IBM 7299 Express Hub supports the faster 2Mbps 5250 Express data stream over UTP

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

New for V4R3 - TCP/IP IP packet security

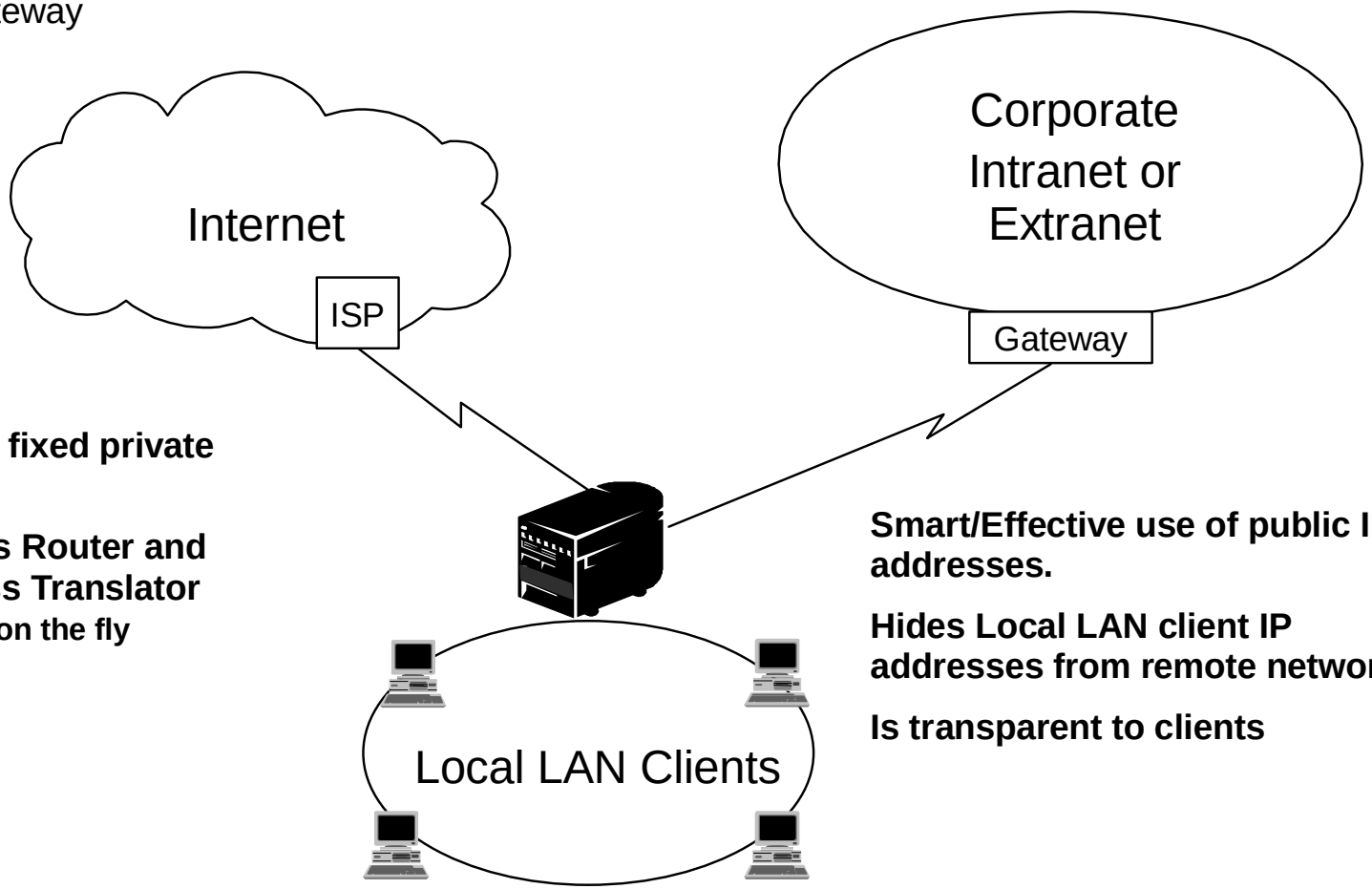
- Part of the base
- In the IP security folder under Network and status of whether rules are loaded and active is shown
- Intuitive user interface providing views of the IP packet filtering rules and Network Adress Translations
- IP packet filtering rules can be verified before they are activated
- Activating and Deactivating IP packet filtering and NAT rules
- IP packet filtering and NAT rules stored as IFS UNICODE files



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Address Masquerading

Allows multiple clients in a local network to simultaneously access remote networks using single IP address assigned by ISP or Remote Gateway



Clients use their fixed private addresses.

AS/400 serves as Router and Dynamic Address Translator
-modifies packets on the fly

Smart/Effective use of public IP addresses.

Hides Local LAN client IP addresses from remote network

Is transparent to clients

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Extended Load Balancing

- **Load Balancing => Splitting workload across :**
  - Multiple processors
  - Multiple interface adapters
  - Multiple host servers
  - Many other options possible

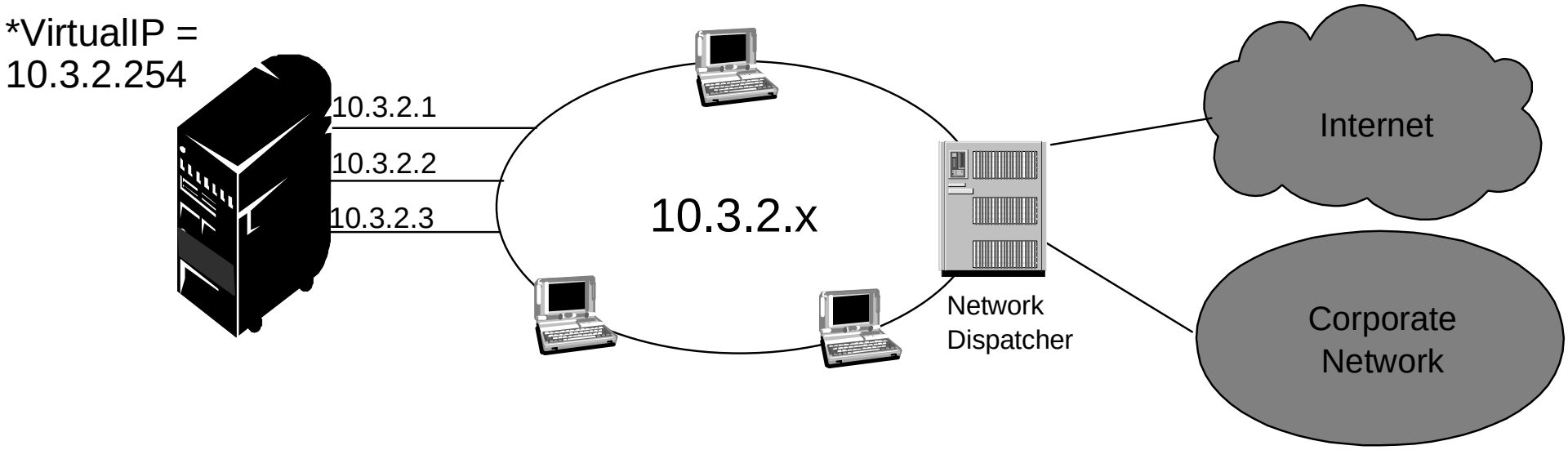
- **AS/400 TCP/IP Based Load Balancing options:**
  - ***V4R2: AS400 DNS based round robining***
  - ***V4R2: Duplicate Route based round robining***
  - ***V4R3: Load balancing with Virtual IP***

- Cost effective approach to increase performance:
  - May only require additional I/O adapters
- Same techniques can split traffic over multiple interfaces or servers
- Transparent to remote users

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Virtual IP Addressing

- **VirtualIP: Externally accessible local IP address unbound to any physical interface**
  - Can be viewed as "*primary*" or "*external*" IP address -- "IP address of the system"
  - IP address by which AS/400 is known externally
  - **Very powerful tool for load balancing, fault tolerance, unnumbered interface anchor, etc.**
- VirtualIP interfaces : Not directly routable
  - Reachable only via indirect route through "physical IP address" (IP address of physical interface)
  - AS/400 will never answer ARP request to *VIRTUALIP address
  - Allows same *VirtualIP address to exist on multiple hosts
- Virtual IP is supported by RIPv2



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

V4R4 TCP/IP Content

Plug and Go Anywhere with Secure Network Access

- Secure inter-site networking through the Internet with Integrated Virtual Private Networking (VPN) for extending intranets and/or quickly creating extranets
  - Interoperability via Internet standards: IPsec and Internet Key Exchange (IKE)
- Standards-based Secure Remote Access (L2TP) for mobile and remote workstations

Scaleable TCP/IP for your Expanding Internet/Intranet Solutions

- TCP/IP infrastructure performance and scaleability
- Secure and scaleable networking middleware:
  - e-mail Transport (SMTP), File Transfer (FTP), Workstation Access (Telnet)
- Extended availability and serviceability features

Easy-to-Use Setup and Administrative Features

- Java-based Graphical User Interfaces for easy setup and administration of VPNs
- Wide Area Network setup wizards

Enterprise-Class TCP/IP for Real Business Networks

- ✓ Built-in secure Virtual Private Networking (VPN)
- ✓ The power to safely exploit the Internet for your networking needs
- ✓ Easy to set up and manage

e-business the Sure Way, The Secure Way

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

V4R4 TCP/IP stack and application enhancements

TCP/IP stack

- Significant performance improvements via stack restructuring
  - Pathlength reduction resulting in a 2x-3x performance improvement
- Peformance improvements RFCs
  - 1191 - Path MTU discovery: dynamically discover the maximum transmission unit (MTU) of an arbitrary internet path
  - 1323 - TCP extensions for high performance: scaled windows and timestamps

TCP/IP applications

- FTP
  - Support for popular graphical FTP clients and Web server development tools
  - Database file CCSID enhancements and null-capable file support
  - Large IFS file support: > 2GB IFS files upto 256 GB
  - Serviceability enhancements
- SMTP
  - Greater performance and capacity: inbound/outbound connections extended from 16 to unlimited
  - Maximum number of Mail Exchanger (MX) records has been increased so that all MX records returned on a query will be handled - Large ISP mail delivery support.
  - Enhanced dial support: When a dial link out is started, the SMTP client retry queues will be automatically retried.
  - Serviceability enhancements
- TELNET
  - TELNET server native support for SSL
  - Serviceability enhancements

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Built upon the V4R3 TCP/IP content

Built-in IP security and management capabilities

- Full GUI configuration and Administration for TCP/IP
- IP Packet filtering for access control
- IP Packet auditing/journaling
- IP Network Address Translation (NAT)
- IP Masquerading: allows multiple users to share a single public IP address
- VIPA (virtual IP addressing): inbound load balancing and fault tolerance

IP security via integrated IPCS firewall

- Link-level data encryption using IPSec with manual keys
- Interoperates with V4R4 integrated VPN solution

Point-to-Point dial-on-demand WAN links

- Can define many logical links with just a few modems
- Very useful for scheduled data moves (i.e. Lotus notes replication)

Enterprise-Class TCP/IP for Real Business Networks

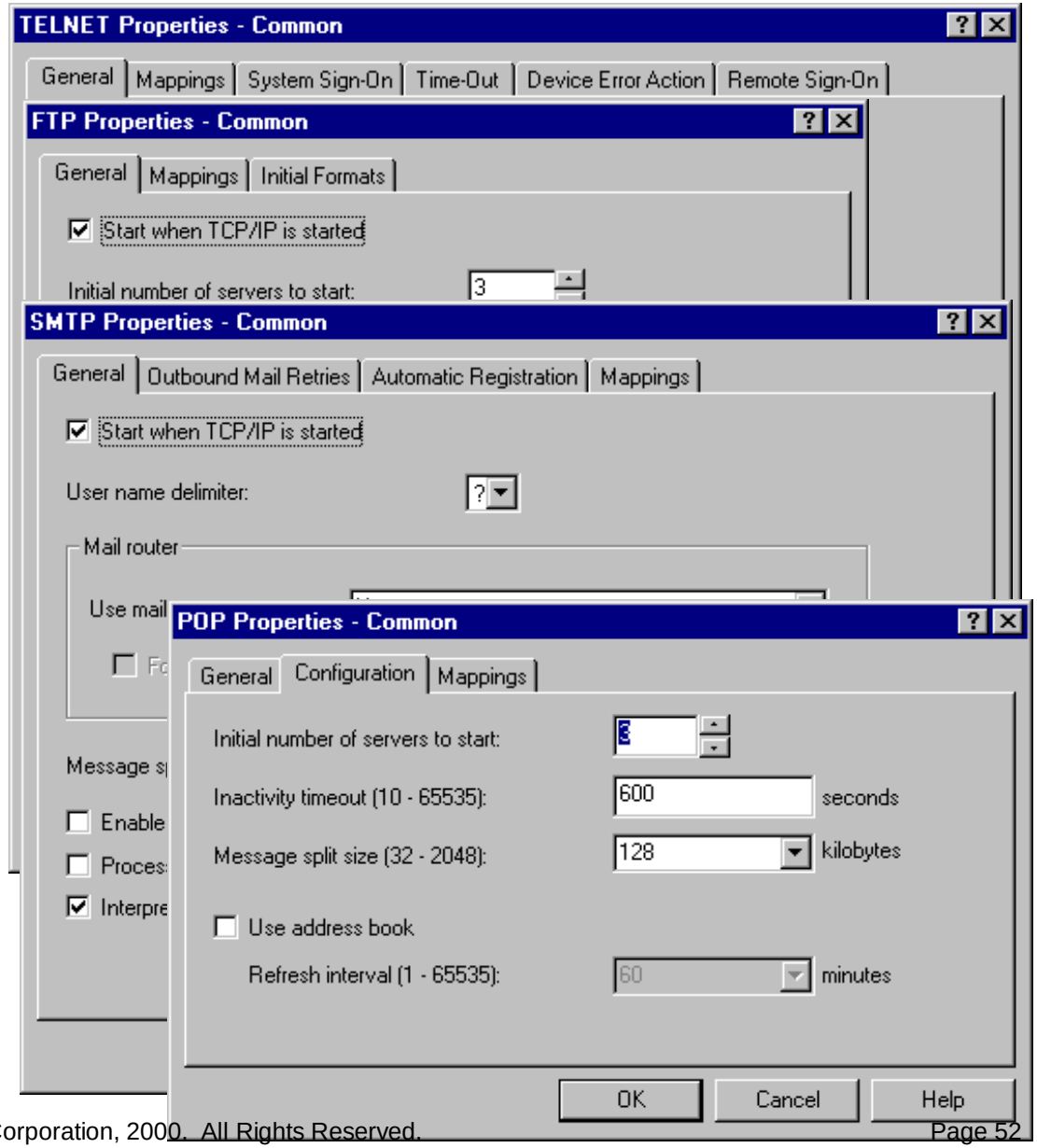
- ✓ Superior TCP/IP intranet security control and management
- ✓ Easy and secure extranets for e-business relationships
- ✓ Low-cost secure internet connections without a firewall

e-business the Sure Way, The Secure Way

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Updated servers in V4R4

- FTP
  - Support for popular graphical FTP clients and Web server development tools
  - Database file CCSID enhancements and null-capable file support
  - Large IFS file support (> 2GB IFS files upto 256GB)
- SMTP and POP
  - Greater performance and capacity
  - MX record handling increased
  - Enhanced dial support for retry
- TELNET
  - Native support for SSL



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

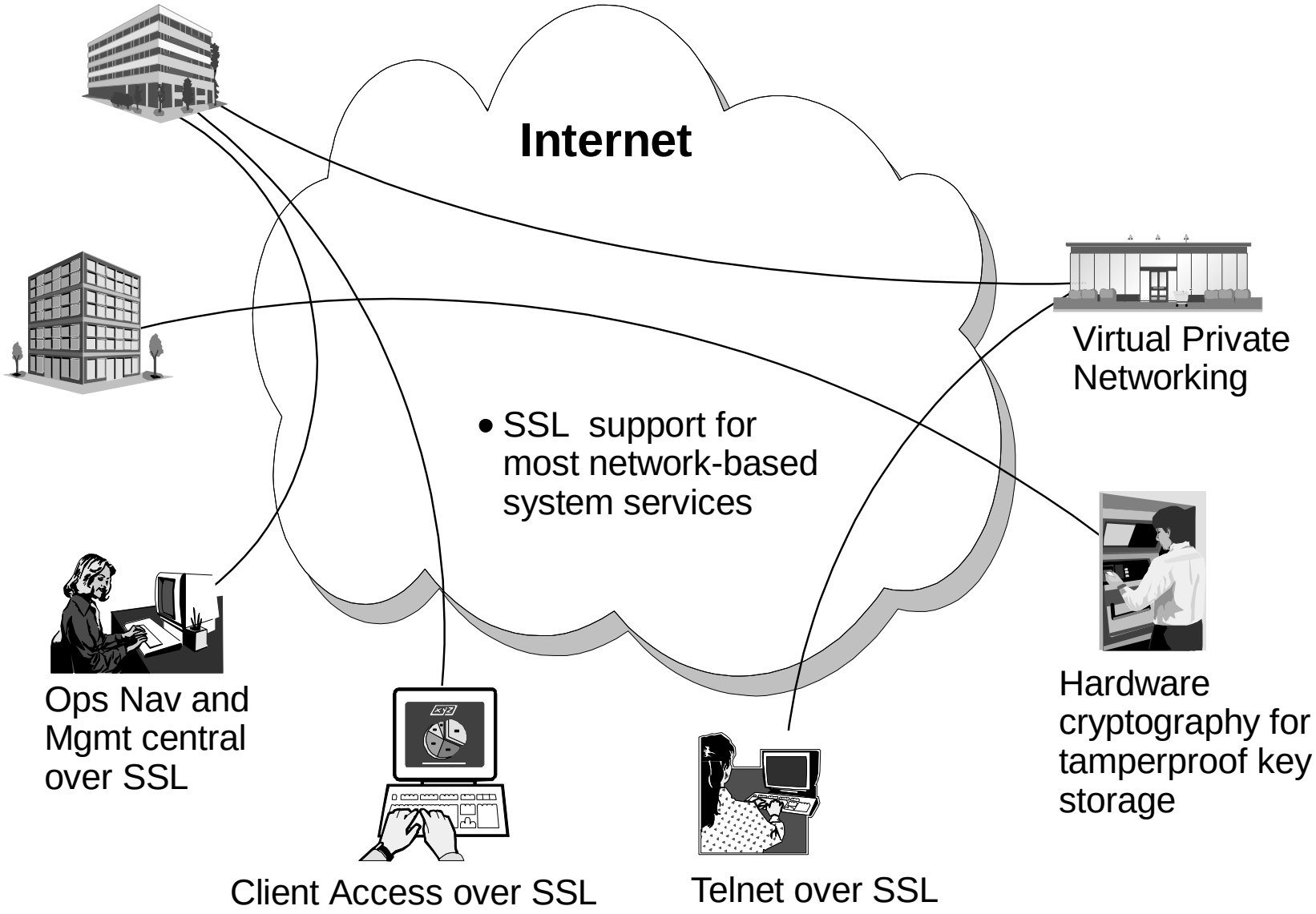
Native Virtual Private Networking support

Run a secure intranet over the Internet

V4R4 enables AS/400 to provide the backbone network services for worldwide anytime anywhere access among employees and distributed applications and data over secure and authenticated connections, even over a public data network such as the Internet. This saves the costs of creating and managing private networks, and serves as the start point for partner and customer linkages.

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

SSL - Safe and secure over the Internet



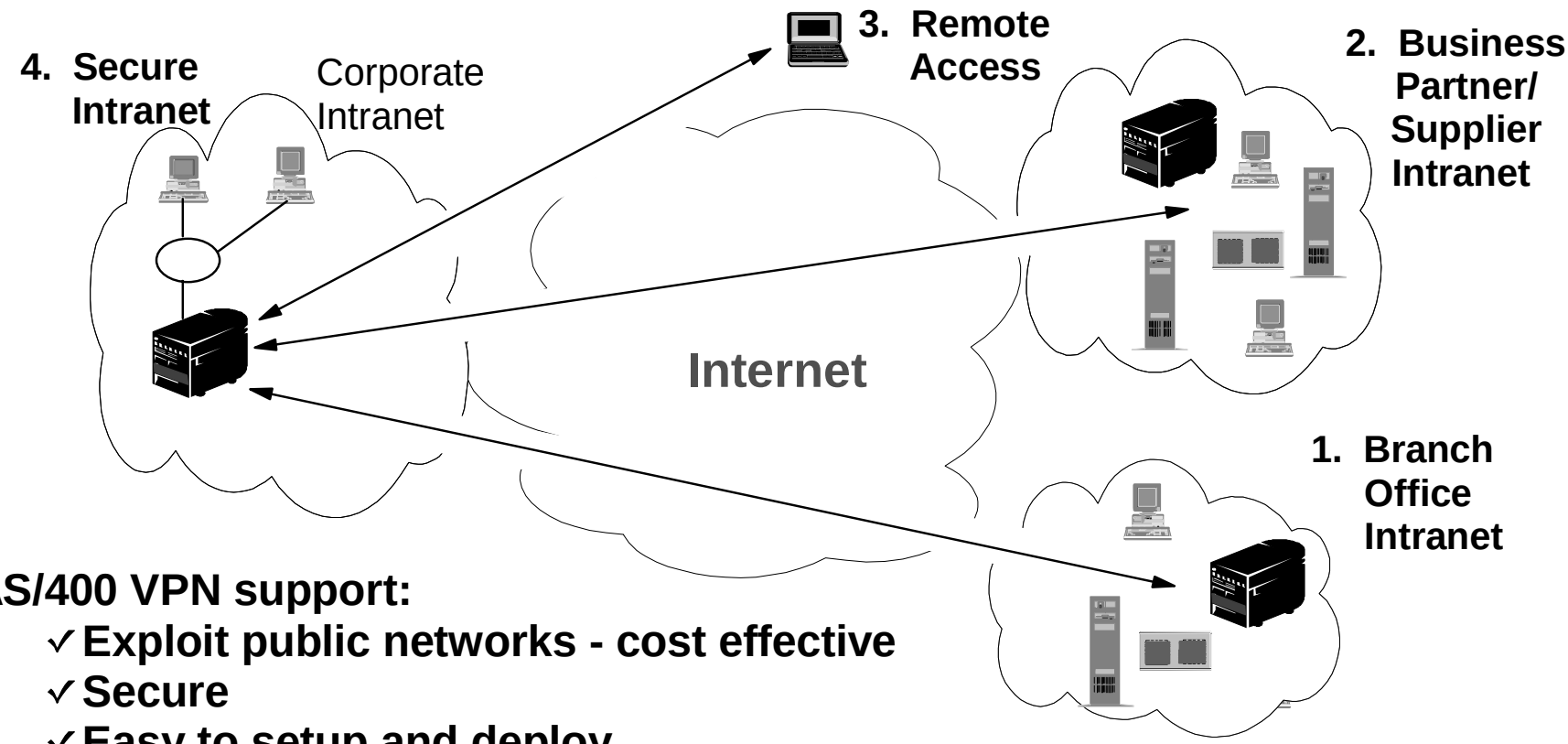
(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Native VPN support highlights

- Based on the latests IETF RFCs ("Leading-edge and interoperable")
  - Manual connections
    - Cryptographic keys and security policies manually defined
  - Dynamic connections using Internet Key Exchange (IKE)
    - Cryptographic keys and security policies are automatically negotiated
  - Support for dynamic IP address assignment (PPP dial-up)
  - L2TP support for remote access via an ISP
  - Java configuration GUI with Wizards integrated into Operations Navigator

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Virtual Private Networking scenarios



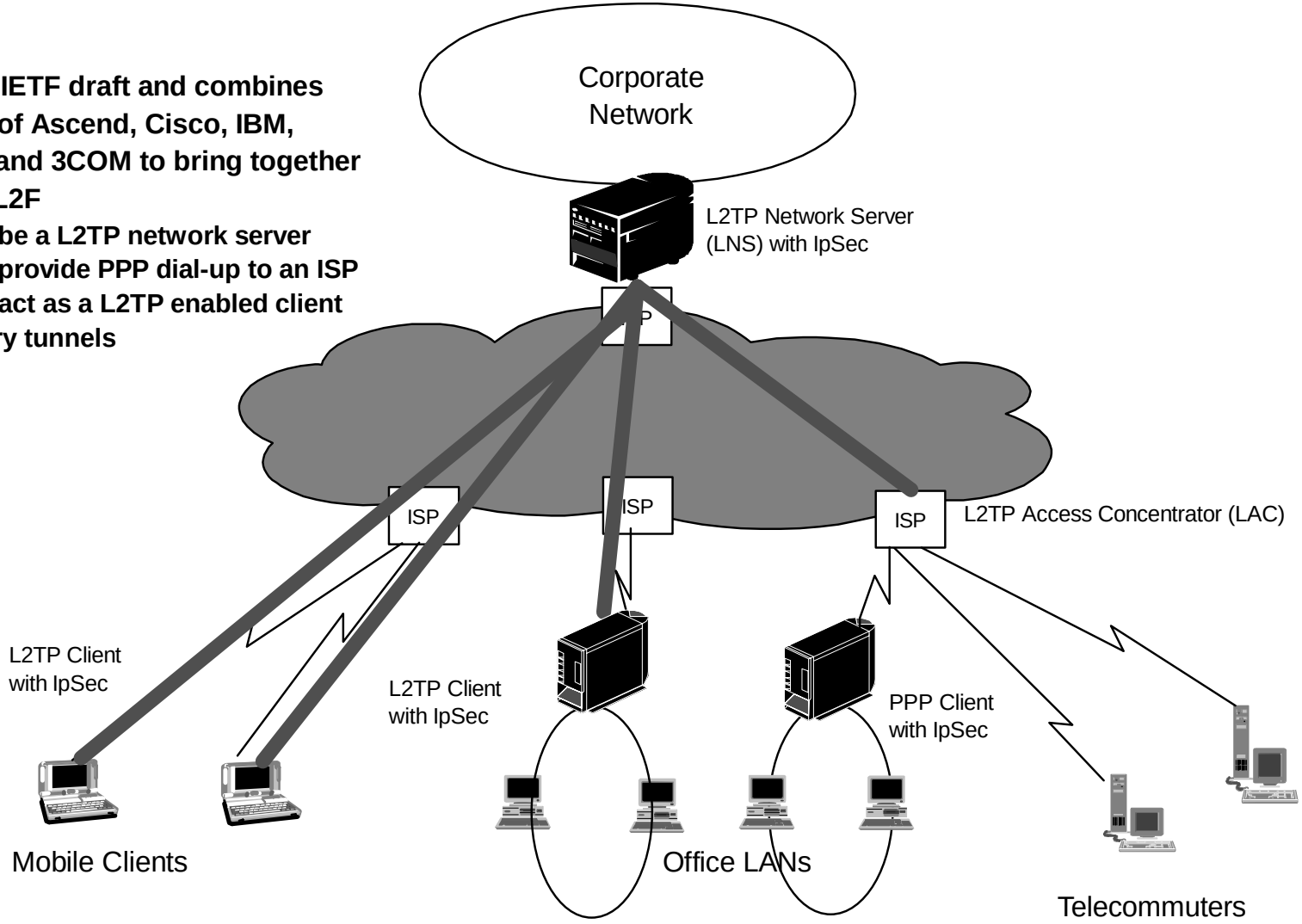
- **AS/400 VPN support:**
  - ✓ **Exploit public networks - cost effective**
  - ✓ **Secure**
  - ✓ **Easy to setup and deploy**
  - ✓ **Standards-based and interoperable**

Business Networks You Can Bank On

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Remote Access/Mobile user - L2TP

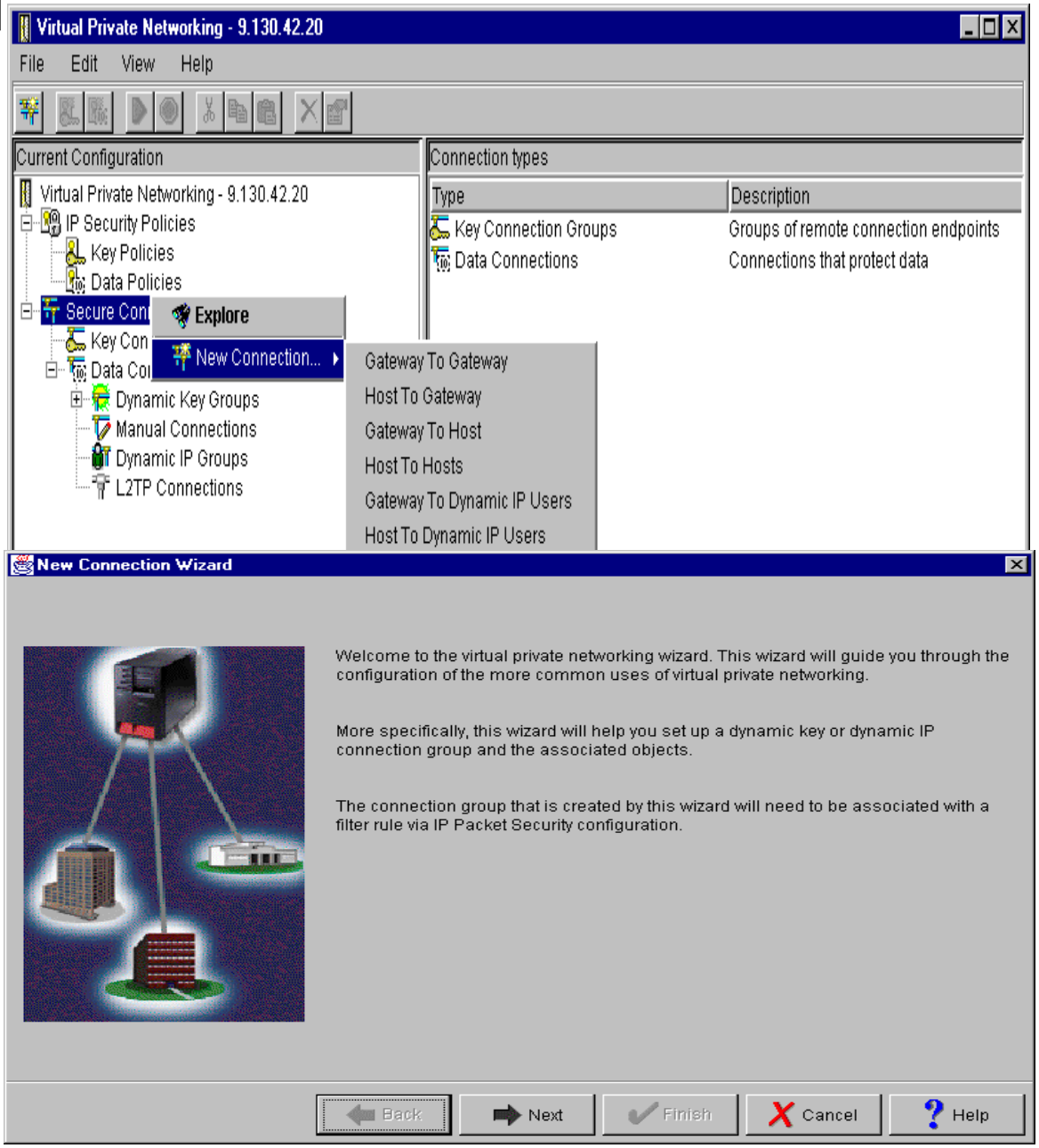
- **L2TP is an IETF draft and combines the efforts of Ascend, Cisco, IBM, Microsoft, and 3COM to bring together PPTP and L2F**
- **AS/400 can be a L2TP network server**
- **AS/400 can provide PPP dial-up to an ISP**
- **AS/400 can act as a L2TP enabled client for voluntary tunnels**



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

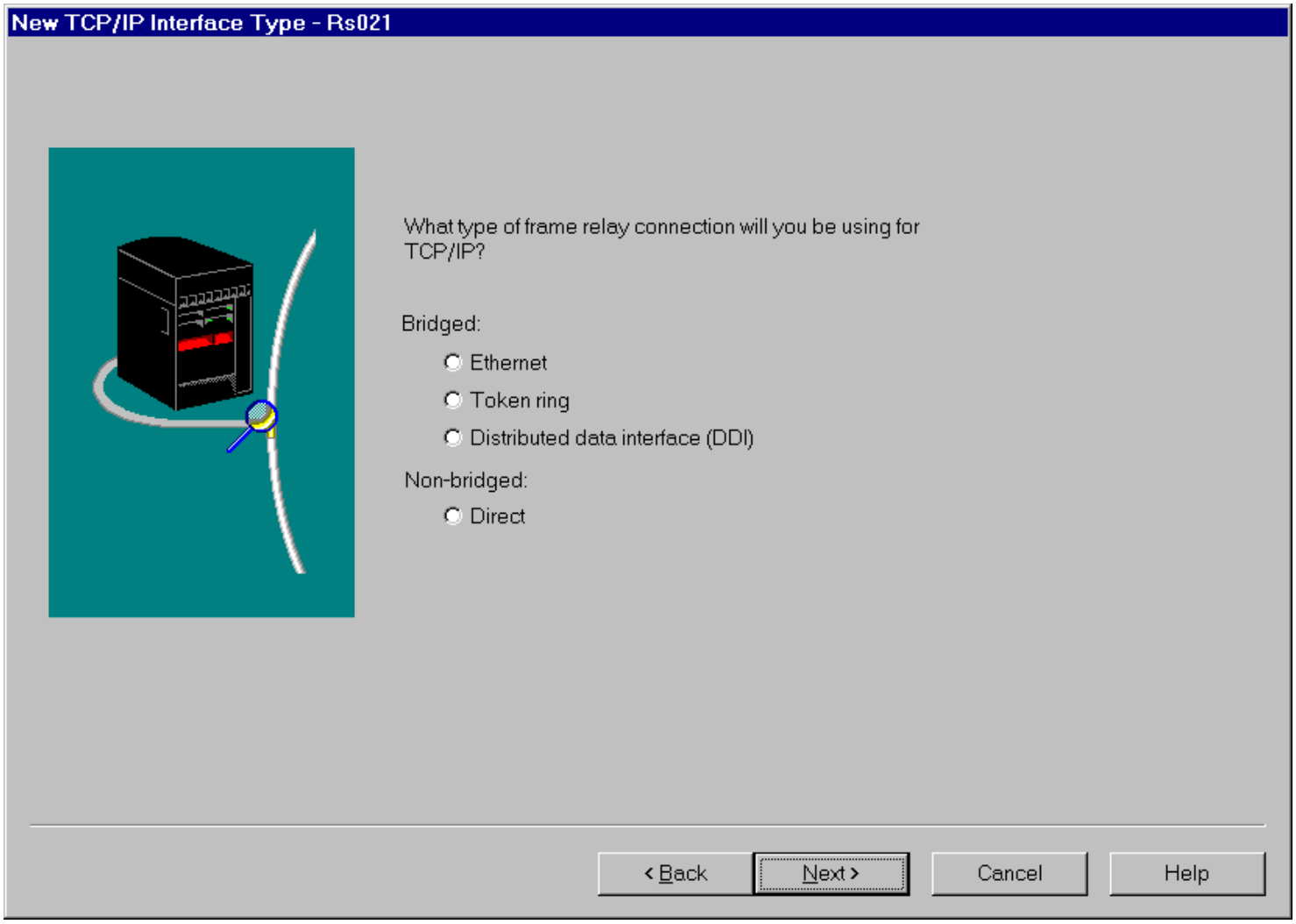
New for V4R4 - VPN

- Part of the base
- In the IP security folder under Network and status of the VPN servers is shown
- Intuitive user interface providing views of the Security policies and Secure connection definitions
- Scenario based wizards supplied for setting up VPNs (Mobile/Remote, Branch office, Extranets)
- Supports starting/stopping and monitoring secure connections
- Filter rule specifies connection group name for protected traffic



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

New for V4R4 - Frame Relay setup Wizard



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Focus on Solutions

Typical TCP/IP Solution Sets

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Intranet Solution 1: Terminal & File Access

Intranet Basics

Terminal Access

- Telnet Server
- Pick a client, e.g. Client Access

File Exchange

- FTP Server
- Pick a client, e.g. built-in Win 95 client

Direct file access

- "Network Neighborhood" server
  - Windows 95/NT clients
- TCP/IP Network File System (NFS)
  - UNIX (and other) clients

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

File Transfer Protocol (FTP)

Reliable transfer of files to and from an AS/400

Client and Server support

Has BINARY, EBCDIC, and ASCII transfer modes

Automatic conversion from EBCDIC to ASCII and vice versa

Lots of client and server subcommands

Client is invoked by STRTCPFTP or FTP CL command

By default, the FTP server is started when STRTCP is run

FTP Security Exits

- Allow customer written exit programs for validation and/or logging of requests
- Ability to implement **anonymous FTP** without compromising system security

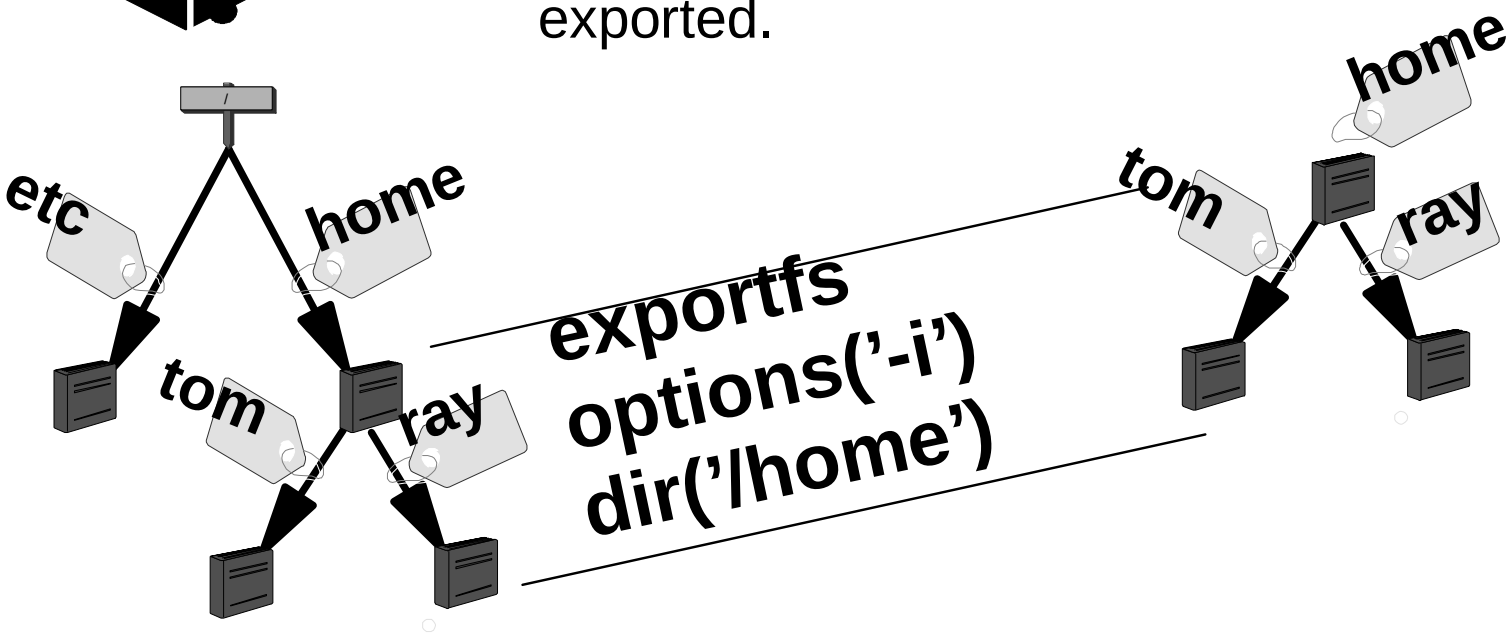
(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Network File System After exporting

NFS server name space

- The client can mount any directory, subdirectory, or file in a remote file system if and only if it has been exported.

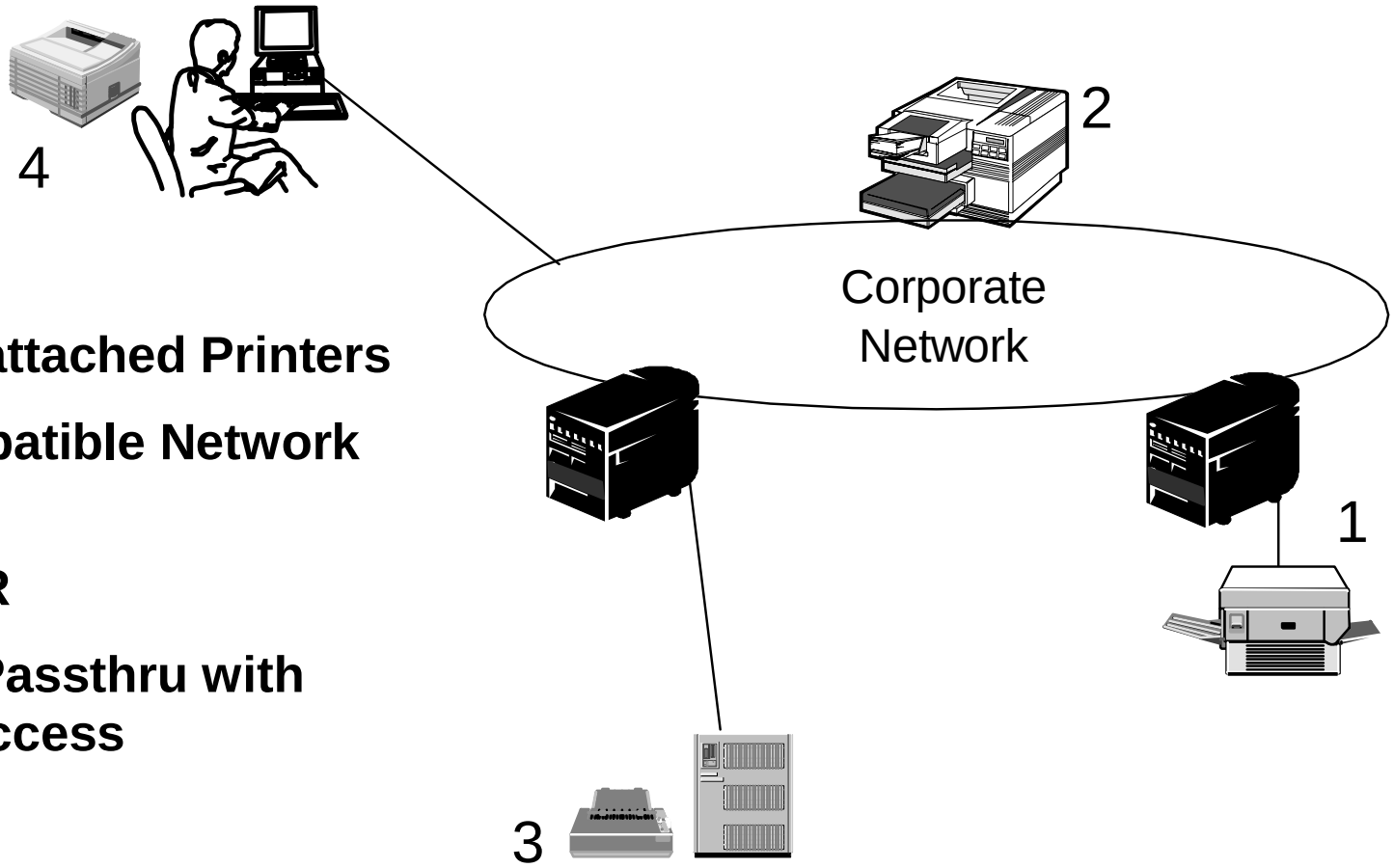
NFS client view



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Intranet Solution 1B: Printing Support

Intranet Basics



1. **AS/400-attached Printers**
2. **HP compatible Network Printers**
3. **LPD/LPR**
4. **Printer Passthru with Client Access**

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Intranet Solution 2: Web and Mail Serving

Install Netscape Communicator on PCs

- It includes both a Web Browser and a POP mail client
- Configure the clients to "point at" the AS/400 mail & web servers

AS/400 built-in Mail Server

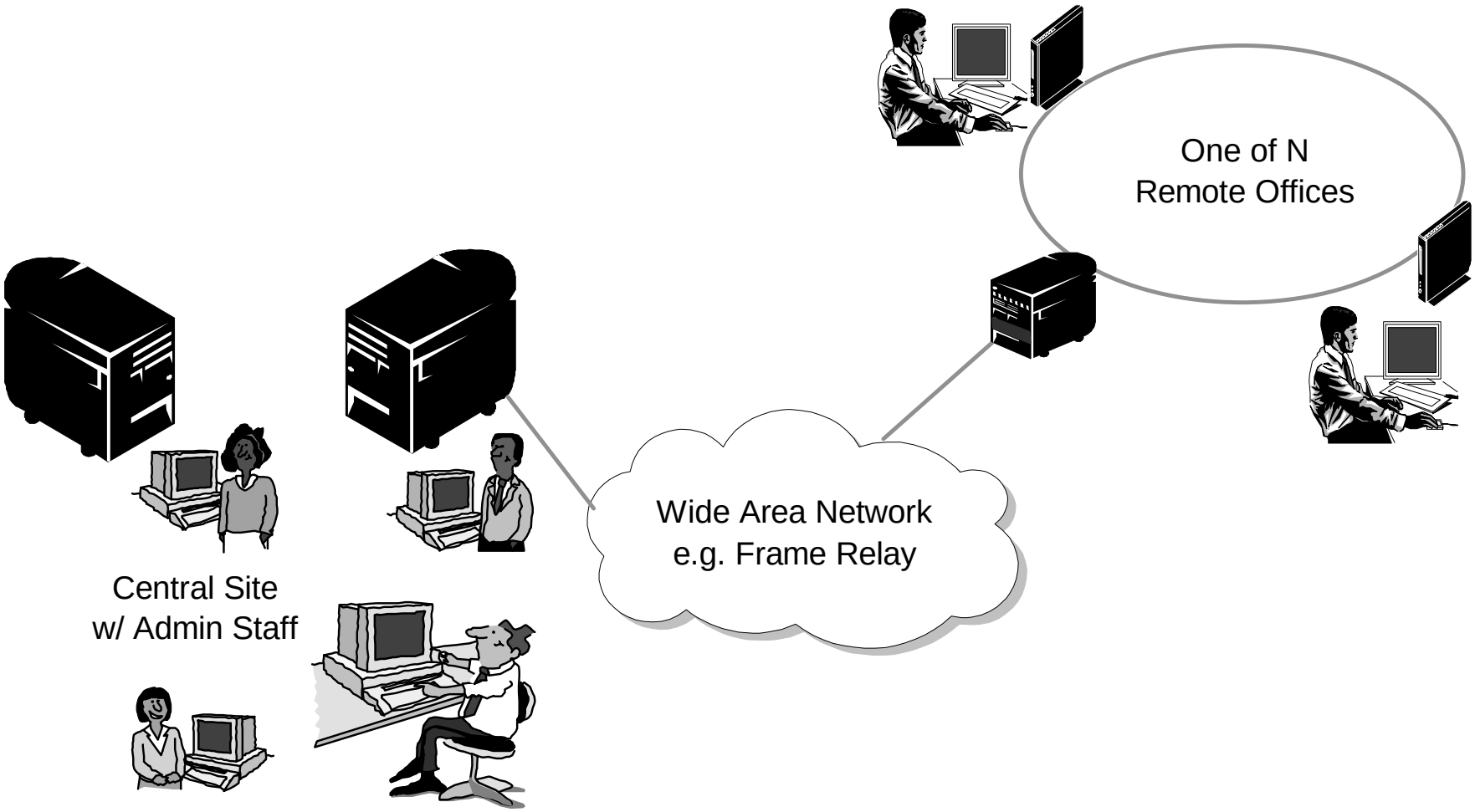
- Define users by creating user profiles and a System Distribution Directory entry (WRKDIRE) for each mail user
- Start POP mail server and SMTP mail transport
- Note: Considering getting Domino for more robust mail

AS/400 built-in Web Server

- Configure and Start HTTP server
- Create some initial web content and make it available by using Web server directives and directory authorities

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Intranet Solution 3: Centrally Managed Remote Offices



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Intranet Solution 3: Centrally Managed Remote Offices...

DHCP: Central Management of TCP/IP Workstation Configuration

- DHCP Server at Central Site
- DHCP/Boot-P Relay Agents at Remote Offices

DNS Name Service: Centrally Managed

- Primary (and Secondary) DNS Servers at Central Site
- Caching DNS Servers at Remote Offices

Lotus Domino Business Applications

- Selectively Replicated to Remote Offices

Highly Reliable & Low Maintenance Remote Office Equipment

- AS/400 manages Media-less Network Stations
- AS/400 forl Domino, DNS, DHCP Relay, Direct Frame Relay & LAN connect
  - No router or PC required at remote offices

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Internet Solution: Web Serving & Mail Exchange

Install a Firewall

- Decide on your policy for allowing access to the Internet from you internal network and configure firewall appropriately
- As a minimum, configure firewall's e-mail proxy agent

Obtain and set up a dedicated external Web server

- This system reside outside the firewall on the perimeter network which is also sometimes called the DMZ

Configure the mail system(s) on your internal network to forward non-local mail to the Firewall for Internet delivery

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 Web Server - What's New in V4R1 & V4R2

Security, Perfomance and Flexibility

Base Web Server included with OS/400

- Internet Connection Server aka ICS/400

Secure IBM Web also available starting in V4R1

- Internet Connection Secure Server aka ICSS/400

Resource Protection

- Access control
- Privacy Ensured through encryption (ICSS/400)

Performance enhancements

Multiple Instances of HTTP Server

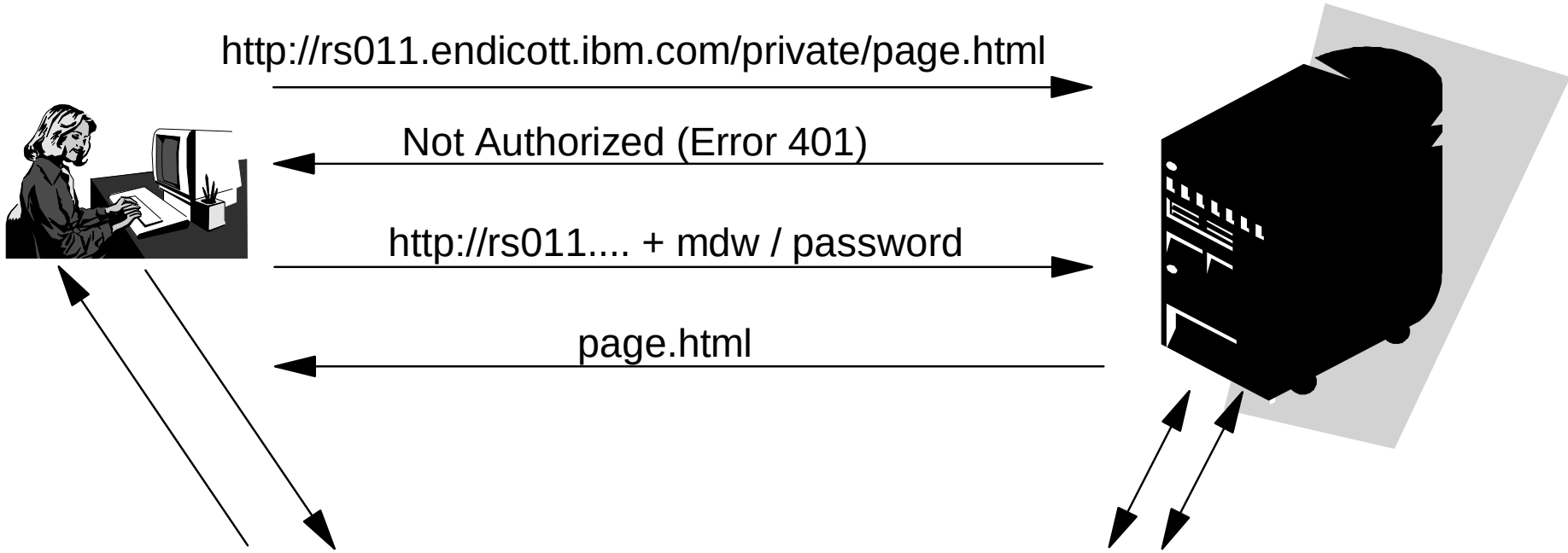
GUI Configuration via WEB Browser

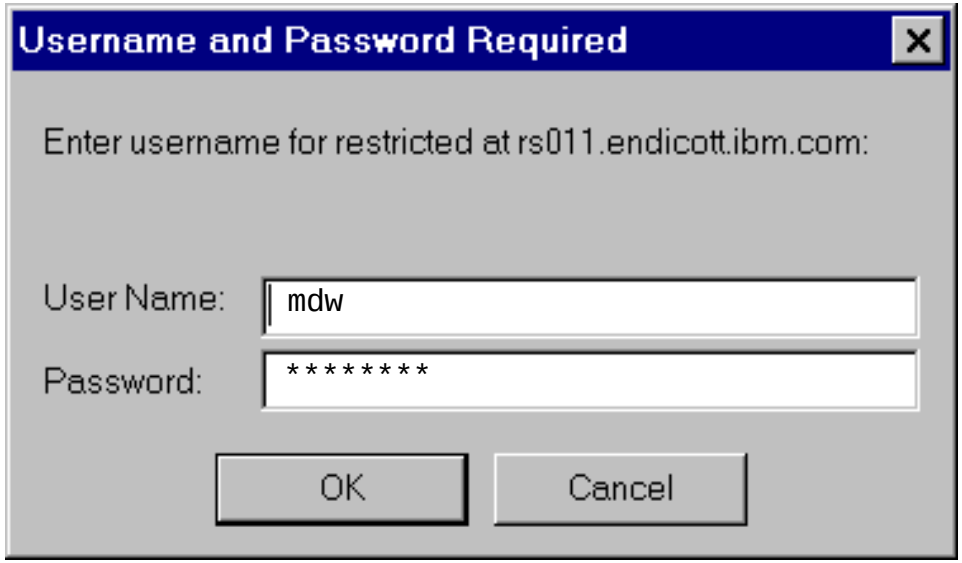
CGI enhancements

Enhanced Logging

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

User Authentication Services






```
#
# Protection setup for all
# files in the /private
# directory.
#
Protect  /private/*   {
   serverID   restricted
   AuthType   Basic
   PasswdFile %%SYSTEM%%
   UserID     %%CLIENT%%
   GetMask    All
}
```


(C) Copyright IBM Corporation, 2000. All Rights Reserved.

HTTPs = Network Privacy

When privacy is a requirement!

HTTPsecure - transactions are encrypted

Invoked with:

- https://your.server.com/some.html

Requires additional product

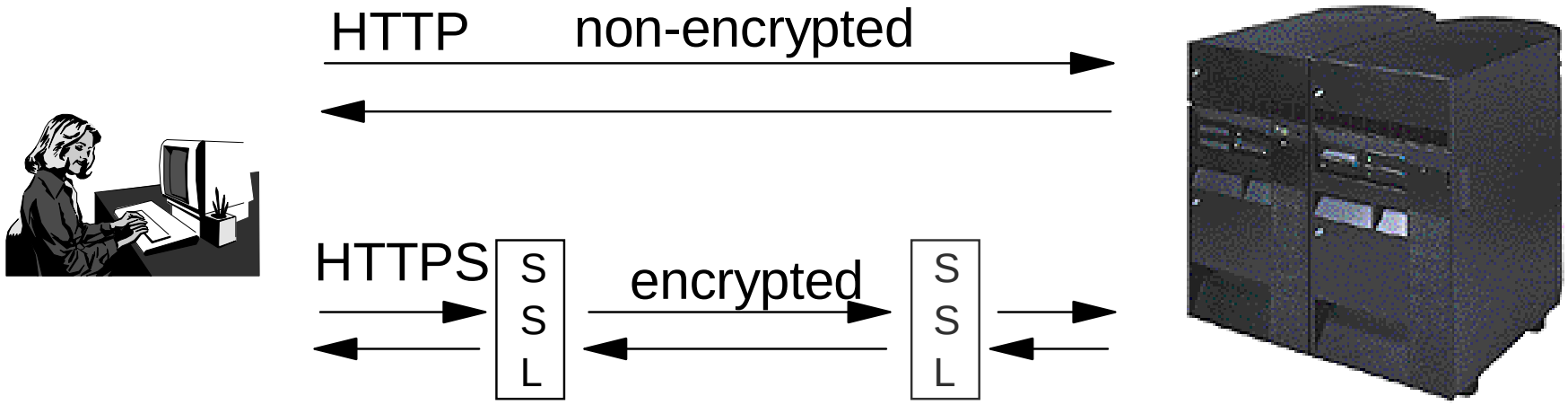
You'll need a "Server Certificate"

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Internet Connection Secure Server

- 5769-DG1 TCP/IP Connectivity Utilities

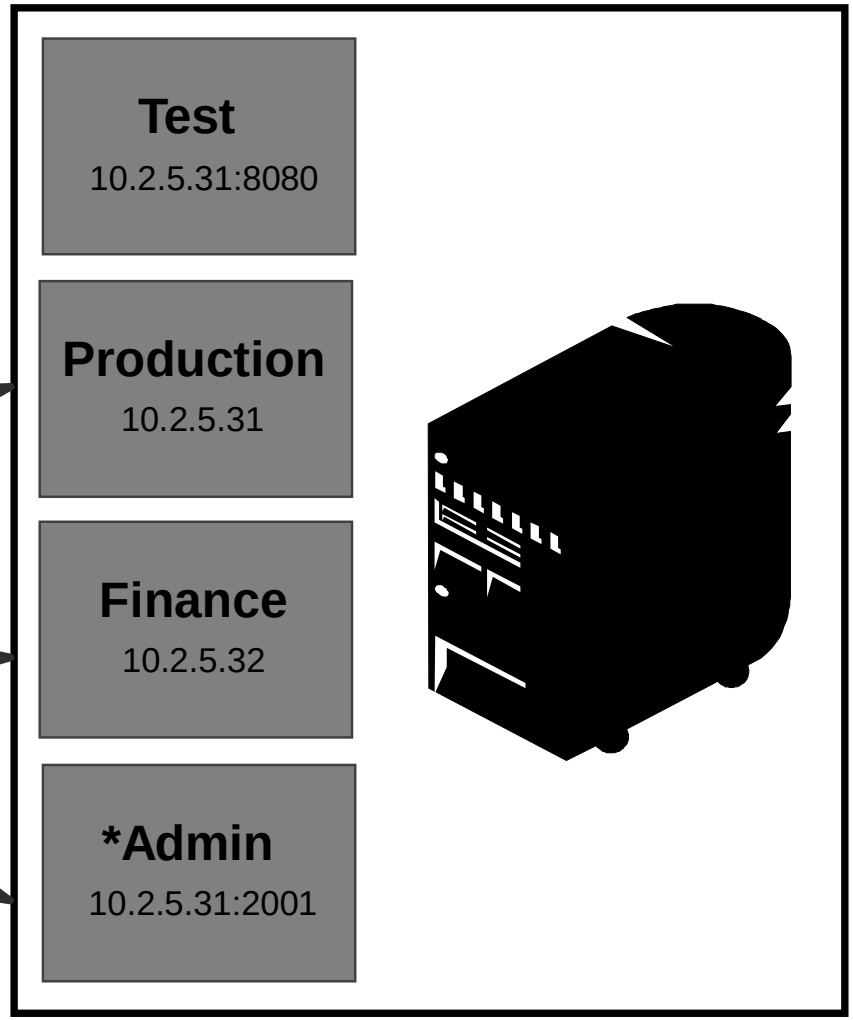
- 5769-NC1 ICSS/400 US/Canada
- 5769-NCE ICSS/400 International



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Multiple Instances: What it looks like....

http://www.wildways.com:8080
http://www.wildways.com
http://finance.wildways.com
http://www.wildways.com:2001



(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Common Gateway Interface (CGI)

Extends the functionality of your web server

Provides "dynamic" content

Allows interactions with your customers

net.data - a CGI application supplied with ICS

- easy way to get sophisticated fast!
- macro language for dynamic content
- multiple languages supported

stdin and stdout have been extended to support

- streaming beyond 256 byte limit
- AS/400 Activation Groups

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 V4 - Robust, Scalable, Integrated TCP/IP

***"The migration to TCP/IP networks and applications continues unabated."* IDC 6/97**

All vendors agree TCP/IP is central to future networking strategy

Most e-business technologies are designed exclusively for TCP/IP

- Internet, Domino, Java, Network Stations, secure web applications, e-commerce

AS/400 delivers a robust, complete and fully integrated TCP/IP suite

- LAN and WAN networking and secure TCP/IP routing support built in
  - 100M Eth, TR, ATM, Frame Relay, PPP, ISDN, Sw56, T1/E1,...
- Complete set of TCP/IP servers and services built in
  - Domain Name Server, DHCP for automated workstation configuration and native IMAP4 Domino mail server
- Client Access over TCP/IP
  - New: printer emulation, selectable device ID and TCP/IP over twinax
- TCP/IP security (IPSec)
- TCP/IP application security and scalability
- Virtual Private Networking (VPN) support with setup wizards

Leading-edge security and enterprise-class TCP/IP for e-business advantage

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

OS/400 TCP/IP Built-in Applications

Overviews, Tips and Hints

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

TCP/IP Packaging on the AS/400

AS/400 TCP/IP is split between functions in base OS/400 and the 57xx-TC1 Licensed Product.

- TC1 is a no-charge product
- Shipped with the OS/400 operating system but must be installed separately.

Base TCP/IP functions in OS/400:

- TCP/IP Configuration and activation/deactivation
- Base TCP/IP stack support - UDP, TCP, ARP, etc.
- PPP, SLIP and Proxy ARP
- SNMP Agent
- DHCP, DNS, RIP versions 1 & 2
- BOOTP, and TFTP servers
- NFS (Network File System) version 2
- Sun RPC and Sockets API including UDP Multicast support
- Utilities (PING, NETSTAT)

The 57xx-TC1 Licensed Product contains the rest of the 'TCP/IP protocol suite' (TCP/IP applications)

- Telnet (Remote Login)
- FTP (File Transfer Protocol)
- SMTP (Simple Mail Transfer Protocol)
- LPD/LPR (Line Printer Daemon/Requester)
- POP3 (Post Office Protocol) mail server
- Internet Connection server (HTTP)
- WSG server (5250/HTML Workstation Gateway)
- REXEC (Remote command EXECution) server and Client

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 TCP/IP Configuration

Allows you to easily configure TCP/IP on your AS/400

- configuration may be changed even when TCP/IP is active

Numerous CL commands are provided, such as:

- Go TCPADMIN - Menu of ALL TCP/IP functions
- CFGTCP - displays a menu of TCP/IP configuration options
- ADD, CHG, RMV, STR, and END TCPIFC (interface)
- ADD, CHG, and RMV TCPRTE (route entry)
- ADD and RMV TCPRSI (X.25 Remote System Information)
- ENDTCPCNN - end specific TCP connection
- CHGTCPA - change TCP attributes
- CHG, SET, and DSP VTMAP (Telnet VT100/VT220 emulation keyboard mapping)
- WRKNAMSMTP (SMTP alias table)

Configuration Objects

- Create a line using CRTLINTRN, CRTLINETH, CRTLINX25 ...
- More than one TCP/IP Interface is possible per line description (multihoming)

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

CFGTCP Command

CFGTCP - TCP/IP specific configuration

- brings up a TCP/IP configuration menu
- configure interfaces and routes
- configure TCP/IP domain information (host name, domain name, domain name servers)
- configure host names in the local host table
- configure SMTP alias tables and attributes
- change TCP/IP attributes and tuning values
- configure X.25 remote system information
- restrict ports to specified users

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

TCP/IP Host Table

Setup of a TCP/IP Host table is necessary if no remote name server exists

- Host Tables allow you to **assign** a host name to an internet address
- For non-trivial TCP/IP networks, management is greatly simplified by using DNS to provide naming services rather than an exhaustive host table duplicated on ever system
- Host Tables should contain an entry for:
  - The **Local Host**
  - All other hosts on the network
- You can import host tables from other systems using the **MRGTCPHT** command

NOTE: You can have up to 4 host names (aliases) with the same internet address

NOTE: May import tables in AS/400, AIX, or NIC format and convert for usage on the AS/400

Host table can be useful even if you use a DNS server to allow operation with at least some systems if the DNS is not working

Always have at least the local system's short and long names in the host table!

- Otherwise, some TCP/IP applications will not work at all when there is a DNS problem because they will not be able to determine the local host information

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Starting and Ending TCP/IP

STRTCP CL Command

- **activates** the TCP/IP protocol structure
- starts the TCP/IP **interfaces** with autostart = *YES
- starts the TCP/IP **server jobs** with autostart = *YES
- can be added to the **QSTRUP** program so start up at IPL time
- corresponding **ENDTCP** CL command ends the TCP/IP servers and protocol support

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Network Status (NETSTAT)

allows viewing of information about TCP/IP configuration and status

provides information on interfaces, **routes**, **and connections**

invoked by the NETSTAT CL command (you can also use the **WRKTCPSTS command)**

information includes:

- interfaces, routes, connection status
- routes associated with an interface
- address/port information
- connection usage: bytes in/out, idle time, etc.

user may act on the information:

- start or end interfaces
- end connections

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Connection Verification (PING)

PING (Packet INternet Groper)

Used to test connectivity between host systems

Useful for testing new configurations - try the following tests in this order for problem determination:

- Can I PING my system's own IP address? (verifies the host is connected to the network)
- Can I PING my DNS? (verifies the Domain Name Server can be reached for hostname resolution).
- Can I PING my router addresses? (verifies that data can be routed to other networks)
- Can I PING a host on ANOTHER network? (verifies that the remote system can be reached via TCP/IP).

Also useful for determining connectivity problems.

Invoked by the PING CL command (VFYTCPCNN is an equivalent command)

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

PING

Problem:

- remote system fails to respond
- the system, network, or gateway is not available or not working
- routes are not configured correctly on the local or remote host

Solution:

- try PINGing your own IP address
  - this verifies that your **local TCP/IP stack** is operational and you are connected to the network.
- try PINGing the router
  - this verifies connectivity to another host on your network and that you can reach the system that allows connectivity to other networks.
- check interface and route statements on the local host
  - use **NETSTAT** to help you here
- try increasing the PING response wait time
  - may indicate delays in the network

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

BOOTP Server

Standard TCP/IP protocol for initializing diskless workstations (ex., IBM Network Station)

Available via PTF in V3R2 and V3R7

- PTF SF39717 for V3R2
- PTF SF42356 for V3R7

Integrated into OS/400 in V4R1

Implements Bootstrap Protocol (BOOTP)

- UDP-based protocol
- Client (workstation) sends packet containing hardware address
- Server (AS/400) responds with packet containing:
  - client host name
  - client IP address
  - gateway (router) address
  - network's subnet mask
  - name of file containing boot image

Use **WRKBPTBL** command to configure client information

- one entry for each client workstation
- use Set BOOTP Table Defaults function key to initialize default values before starting

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

TFTP Server

Implements Trivial File Transfer Protocol (TFTP)

Availability same as BOOTP server

- same PTFs for V3R2 and V3R7

"lightweight" file transfer capability

- UDP-based
- extremely simple transfer/acknowledgement protocol
  - does **not** perform well on high-latency or "lossy" networks
- **no user authentication**
  - server always runs under QTFTP user profile
  - access restricted to files residing in:
  - IBM Network Station default directory
  - alternate directory configured with **CHGTFTPA** command
  - QTFTP profile must have authority to file
- AS/400 implementation provides exit point
  - allows file access to be restricted by IP address
  - same exit point format as existing FTP exit

Primary use is for loading diskless workstations

- ex., IBM Network Station

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

REXEC Server

New in V4R1

REXEC is a "well-known" protocol for running commands on a remote system

Basic protocol:

- client initiates connection
- client can specify port for return of error information
  - if no port specified, error information is returned on same connection as command output
- client sends user name, password, and command to be run
- server validates the user, runs the command, returns regular and error output

AS/400 REXEC server implements exit points for additional access control

- same formats as existing FTP exit points

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

REXEC Considerations

Can only run commands allowed in a batch job

AS/400 REXEC output considerations:

- data written to default printer file is returned as command output
  - since REXEC server runs as batch job, this includes data which would be written to the "screen" in an interactive job
- any messages written to the job log are returned as error output

RUNRMTCMD command is AS/400 REXEC client

- available since V3R6
- part of OS/400 Host Servers option
- only uses single connection (command output and error information may be intermixed)
- returns data to spool file on client AS/400
- can be used to run commands on non-AS/400 systems running an REXEC server
- also implements AREXEC (SNA APPC version of REXEC protocol)

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

REXEC Client (RUNRMTCMD)

Allows AS/400 users to run commands on a remote system

Remote system must be running rexecd (TCP/IP) or **arexecd** (APPC)

Local system (AS/400) waits for remote command to complete and places any output from the command into a spool file

Enclose command in apostrophes if it contains embedded blanks or special characters

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

POP3 Mail Server

AS/400 POP3 mail server introduced in V3R2/V3R7

POP3: Post Office Protocol ver. 3

- Popular Internet mail server protocol
- True client-server application
- Server stores mail for retrieval by client
  - each user has "P.O. Box" on the server
- When user connects with client, can either
  - "peek" and leave on server
  - download to client and delete from server
- Includes support for disconnected mail clients
  - user can download mail then read off-line

Many free-ware client implementations available

Full-function POP3 clients are available for all major client platforms

- OS/2, Windows, MAC, and UNIX
- mail function on most browsers is POP3-based

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

POP Server Considerations

To store and retrieve mail with the AS/400 POP server:

- user must have a valid AS/400 user profile
- the user must be enrolled in the System Distribution Directory using the **ADDDIRE** command:
  - Mail service level must be set to 2 (System message store)
  - Preferred address should be set to 3 (SMTP name)
  - User's SMTP name and domain must be entered in system alias table (F19 from Add Directory Entry screen)

Mail is stored in /QTCPTMM directory structure of "root" file system until delivered/deleted

- may need to consider backing up this directory structure for disaster recovery purposes

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Simple Mail Transfer Protocol (SMTP)

The TCP/IP electronic mail transport protocol

- based on end-to-end delivery

Allows AS/400 to transfer electronic mail with virtually any other system

Includes built-in interoperability with SNADS (OfficeVision/400):

- Sends notes, messages, and FFT documents

SMTP is integrated with AnyMail/400 aka Mail Server Framework (MSF)

- Permits custom extensions to e-mail handling

Option to direct non-local mail to Internet firewall

Extended Mail management enablement coming soon (via PTFs)

- Additional Entries for SMTP in MSF journal

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

SMTP Hints

How to determine if mail is working on the system:

- Check if SMTP jobs (QTSMTPBRCL, QTSMTPBRSR, QTSMTPCLNT, QTSMTPSRVR) are active in QSYSWRK subsystem - (WRKACTJOB)
  - If using OV/400, also check if jobs under QSNADS subsystem are active
- Check for a recipient entry in the system directory (WRKDIRE)
  - Make sure entry has a correct SMTP name defined
- Check if local domain name is correct (CFGTCP option 12)
- Check if there is at least 1 QMSF job running in QSYSWRK subsystem (WRKACTJOB) - AnyMail/400 Mail Server Framework

Other hints:

- *ANY and local system name should not be in the system directory
- Converting Spool files into FFT docs
  - There is a sample Cobol/CL program in the AS/400 Office Services Concepts and Programmers guide (SC41-9758) that will convert a spool file into an FFT doc that can be sent out SMTP by SNDDST
- If you have need for SMTP userids > 24 characters, you can put the entry in the System Alias table's route field (i.e.. userid@host.domain).
  - Warning: Make sure syntax is correct, there is **no** validation on tthis field!

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

File Transfer Protocol (FTP)

Reliable transfer of files to and from an AS/400

Client and Server support

Has BINARY, EBCDIC, and ASCII transfer modes

Automatic conversion from EBCDIC to ASCII and vice versa

Lots of client and server subcommands

Client is invoked by STRTCPFTP or FTP CL command

By default, the FTP server is started when STRTCP is run

FTP Security Exits

- Allow customer written exit programs for validation and/or logging of requests
- Ability to implement **anonymous FTP** without compromising system security

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

FTP

Support transfer of

- **physical files** (default)
  - new file created on AS/400 by FTP is a physical file (default)
  - uses standard defaults except that MAXMBR is set to *NOMAX
  - performs better if files are pre-created
- **source physical files**
- **save files**
- **Document Library Services** (DLS) folders and documents
- **Integrated File System** support
  - Allows transfer of files to and from the **root ("/")**, **QOPENSYS, QLANSRV, ...** file systems
  - Files may be stored to root or QOPENSYS in ASCII or EBCDIC
  - QLANSRV files are stored in ASCII

FTP server will default to your user profile's specified current library

- use the **cd** (change directory) command to change the default server directory and the **lcd** (local change directory) command to change the client default directory

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

FTP

Two naming formats:

- NAMEFMT 0 (default) - **library/file.member**
  - Supports physical file members, source physical file members, and save files which already exist
- NAMEFMT 1
  - Integrated File System file name syntax
  - Supports all types of AS/400 files including
  - documents/folders
  - Integrated File System files
  - database files and members
  - Naming examples:
  - save file - **/QSYS.lib/QGPL.lib/mysave.savf**
  - physical file member - **/QSYS.lib/QGPL.lib/myfile.file/mymem.mbr**
  - OfficeVision document - **/QDLS/JDB/My.Doc**
  - root file system file - **/home/myprofile/my.file**
  - **SITE NAMEFMT 1** from non-AS/400 client to change format on AS/400 FTP server

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

FTP Hints

QUOTE RCMD to AS/400 SERVER FTP allows remote execution of CL commands

- may only send back success or failure message

SYSCMD subcommand for AS/400 CLIENT FTP executes AS/400 CL command

- may also press F21 on client to get CL command line window

TRAILING Blanks are handled on a record basis

- added when writing to database files, removed when reading from database files

Watch out for record length of files when using **automatic** file creation of database files

- record length will be set to the longest record of the first member received, may cause truncation of subsequent members

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Network File System After exporting

NFS server name space

- The client can mount any directory, subdirectory, or file in a remote file system if and only if it has been exported.

NFS client view

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 Telnet Support

The TELNET protocol allows you (the **TELNET client**) to access the resources of another system (the **TELNET server**) as if your terminal were locally connected to the server system

Client TELNET Support

- **5250** full screen mode
- **3270** full screen mode
- **VT220** mode
- **VT100** mode
- **ASCII** line mode

Server TELNET Support

- **5250** full screen
- **3270** full screen
- **VT220** mode
- **VT100** mode
- **ASCII** line mode (requires customer programming)

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Start Client TELNET

To start a TELNET client from an AS/400 system, enter the STRTCPTELN or TELNET command.

Negotiates "best fit" terminal emulation with the Telnet server

- 5250 -> 3270 -> VT220 -> VT100

Options include:

- keyboard mapping tables
- 5250-unique key handling (ex., PageUp, PageDown)
- ASCII <--> EBCDIC character conversions
- many VT220/VT100 specific options
- connection port
  - allows Telnet client to be used to communicate with other compatible TCP applications
  - can be used for debugging server problems (for example, seeing what response SMTP server gives for a specific scenario)

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Server TELNET Functions

A server TELNET session is initiated on the AS/400 by starting a TELNET session from a remote system to the AS/400

A TELNET user does not need to request a terminal type; the AS/400 TELNET support automatically negotiates the optimum level of support with the remote system

A Virtual Workstation device matching the negotiated terminal type is automatically selected (created if necessary) when a TELNET session starts

Virtual devices names QPADEVxxx

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Server Keyboard Mapping

The user can configure the keyboard map from within a server TELNET session using CL commands after signing on

For 3270 TELNET sessions:

- SETVTMAP and CHGVTMAP modify the current VT100 or VT220 keyboard map

For VT100 or VT220 TELNET sessions:

- SETVTMAP and CHGVTMAP modify the current VT100 or VT220 keyboard map

Changes made using these commands affect only the session from which they are issued

The DSPKBDMAP and DSPVTMAP commands can be used to display the current keyboard map

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

LPR and LPD
Line Printer Requester and Line Printer Daemon

LPR

- Provides the client function to send a spool file to destination systems which support an LPD process for printing
- **SNDTCPSPLF** is the CL command (you can also use **LPR**)

LPD

- A process on the destination system that will receive the file sent using LPR and places it on a local print queue
- AS/400 LPD will receive print requests from both AS/400 and non-AS/400 systems.
- It will attempt to create the spool file on the output queue specified in the received request
- A control file is used to pass all of the printing options and attributes that were selected on the LPR command to the LPD process on the destination system
- The information in the control file will ALWAYS be in ASCII
- A data file contains the data stream to be printed

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

LPR and LPD

LPR/LPD supports the following:

- Provide inbound and outbound remote printing support
- Remote printing of AS/400 generated spooled files
- AS/400 printing of remotely generated files
- EBCDIC to ASCII translation (outbound)
- multiple remote printer types (outbound)
  - look at parameter **MFRTYPMDL** in the SNDTCPSPLF command
- Compliant with the Internet standard RFC 1179
  - A subset of the print commands, options, and attributes are supported
- Makes use of Host Print Transform for ASCII printer support

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

LPR Hints

LPR Implementation

AS/400 implementation of LPR is for spool files only - no data base files may be sent

If the file to be sent has a data stream type of System Network Architecture Character String (SCS), an option to convert it to American National Standard Code for Information Interchange (ASCII) is provided

The user can only send spool files they have access to on their AS/400

Printer queue - use naming convention of the system you are sending to examples:

- AS/400 specify an output queue
- OS/2 specify a printer device name
- UNIX based system specify a printer queue

Spool file name must be fully qualified if it is not the last one generated

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

AS/400 SNMP

Industry standard Simple Network Management Protocol (SNMP)

AS/400 as SNMP Agent

- Allows AS/400 to be managed by remote host
- Uses Management Information Base (MIB) objects for example:
  - MIB-II
  - APPN MIB
  - Client Management MIB
  - MIBs may be dynamically added by vendors or customers by exploiting the SNMP Subagent API

AS/400 as SNMP Manager

- NOT supported but the framework to write an SNMP manager using API's is available

AS/400 SNMP Manager Framework

- Provides a rudimentary base for creating SNMP applications
- Supports SNMP Application Program Interfaces (API's)
- Supports a Trap manager (to work with traps)
- A Facility exists to convert Alerts to Traps

Full Internet Standard (RFC 1157) compliant

Uses UDP protocol - connectionless

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Sockets API Support

Open, Portable interprocess communications

- 1000's of sockets applications available today

Common programming interface for the industry

Works over TCP/IP or SNA via AnyNet/400

Connection -oriented (TCP) or connectionless (UDP)

Full Duplex

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Related AS/400 Products

Internet Connection Secure Server for AS/400

- new product for V4R1
- implements secure HTTP protocols
- highly recommended for Internet commerce applications
- 2 versions:
  - 5769-NC1 only available in U.S. and Canada
  - 5769-NCE exportable to most countries

IBM Firewall for AS/400

- new product for V4R1
- secure firewall for AS/400
- runs on Integrated PC Server (IPCS)
  - physically separate TCP/IP stack - prevents Internet attacks from affecting AS/400
- provides WWW proxy server, SOCKS server, mail server, DNS, and IP filtering functions

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

References

Bibliography and Glossary

Where to find additional information

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Bibliography

Note: All IBM AS/400 publications can be viewed and ordered on the Internet at:
http://as400bks.rochester.ibm.com

AS/400 Communications manuals:

- AS/400 TCP/IP Configuration and Reference
  - V3R1/V3R6 - SC41-3420-01
  - V3R2/ V3R7 - SC41-3420-04
  - V4R1 - SC41-5420-00
- TCP/IP Fastpath Setup
  - V3R2/V3R6/V3R7 - SC41-3430
  - V4R1/V4R2 - SC41-5430
- IBM ICS/ICSS Quick Beginnings (for Web serving)
  - V4R1/V4R2 - GC41-5433
- IBM ICS/ICSS Webmaster's Guide
  - V4R1/V4R2 - GC41-5434
- Web Programming Guide
  - V4R1/V4R2 - GC41-5435
- OS/400 Simple Network Management Protocol (SNMP) Support
  - V3Rx - SC41-4412
  - V4R1 - SC41-5412
- OS/400 Network File System Support
  - V3R7 - SC41-4714
  - V4R1 - SC41-5714
- Firewall for AS/400 - SC41-5424

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Bibliography...

Red Books:

- TCP/IP Tutorial and Technical Overview - GG24-3376
- Communications Systems Bulletin on TCP/IP - GG22-9125
- Cool Title About the AS/400 and Internet Goes Here - SG24-4815-01
- A Guide to the Internet Connection Servers - SG24-4805
- AS/400 SNMP - SG24-4504
- AnyMail/400 Mail Server Framework Developer Guide - GC24-4449
- AS/400 - IBM Network Station - Getting Started - SG24-2153
- Using the Information Super Highway - GG24-2499
- AS/400 e-commerce: Internet Connection Servers - SC24-2150
- Unleashing AS/400 Applications on the Internet - SG24-4935
- AS/400 TCP/IP Autoconfiguration: DNS and DHCPSupport - SG24-5147 (COMING SOON)

AS/400 Programming manuals:

- AS/400 Sockets Programming - SC41-3422
- ILE C/400 Programmer's Guide - SC09-1820
- ILE C/400 Programming Reference - SC09-1821

AS/400 Security manuals:

- Tips and Tools for Security Your AS/400 - SC41-3300
- IBM SecureWay: AS/400 and the Internet - G325-6321
- Internet Security: Securing Your AS/400 from HARM in the Internet - SG24-4929

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Bibliography...

General TCP/IP information :

- TCP/IP Illustrated, Vol. 1: The Protocols by W. Richard Stevens (ISBN 0-201-63346-9)
- TCP/IP Illustrated, Vol. 2: The Implementation by Gary Wright and W. Richard Stevens (ISBN 0-201-63354-X)
- TCP/IP Illustrated, Vol. 3: TCP for Transactions, HTTP, NNTP, and the Unix Domain Protocols by W. Richard Stevens (ISBN 0-201-63495-3)
- The Simple Book: An Introduction to Management of TCP/IP - Based Internets by Marshall T. Rose
- Internet Primer for Information Professionals by Elizabeth Lane and Craig Summerhill

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Glossary

API Application Program Interface

APPC Advanced Program-to-Program Communication

APPN Advanced Peer-to-Peer Networking

ARPA Advanced Research Projects Agency

ARP Address Resolution Protocol

ASCII American Standard Code for Information Interchange (7 bit)

BOOTP Bootstrap Protocol

CLIENT Initiating side of a work request (Source)

CSMA/CD Carrier Sense Multiple Access with Collision Detection

DHCP Dynamic Host Access Protocol

DLC Data Link Control

DNS Domain Name Service

DSAP Destination Service Access Point

DTE Data Terminal Equipment

EBCDIC Extended Binary-Coded Decimal Interchange Code (8 bit)

Ethernet 802.3 LAN prorocol - a "best-effort" delivery system that uses CSMA/CD

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Glossary...

ELAN Ethernet LAN

FFT Final-Form Text (document)

FTP File Transfer Protocol

GUI Graphical User Interface

HTML Hypertext Markup Language

HTTP Hypertext Transfer Protocol (the Web client/server protocol)

IEEE Institute of Electrical and Electronics Engineers

IETF Internet Engineering Task Force (standards body of the Internet)

ICMP Internet Control Message Protocol

ICF Intersystem Communications Function

IP Internet Protocol

LAN Local Area Network (e.g. Token Ring, Ethernet and DDI)

LLC Logical Link Control

LPO Licensed Program Offering

LPD/LPR Line Printer Daemon (server) / Line Printer Requester (client)

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Glossary...

MVS Multiple Virtual Storage operating system on S/390

NC Network Computer

NIC Network Information Center

NFS Network File System

NNTP Network News Transfer Protocol

OEM Original Equipment Manufacturer

PING Packet InterNet Groper

PPP Point to Point Protocol

PVC Permanent Virtual Circuit

RFC Request For Comments (i.e. Internet standards)

RFT Revisable-Form Text (document)

RIP Routing Information Protocol

RPC Remote Procedure Call

SAP Service Access Point

Server Servicing Entity (target)

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Glossary...

SMTP Simple Mail Transfer Protocol

SNA Systems Network Architecture

SNMP Simple Network Management Protocol

SLIP Serial Line Internet Protocol

SNADS SNA Distribution Services

SSAP Source Service Access Point

SVC Switched Virtual Circuit

TCP Transmission Control Protocol

TELNET Simple Remote Terminal Protocol

TFTP Trivial File Transfer Protocol

TRLAN Token-Ring LAN

TRN Token-Ring Network

UDP User Datagram Protocol

VM Virtual Machine operating system

WWW World Wide Web

(C) Copyright IBM Corporation, 2000. All Rights Reserved.

Trademarks

NFS is a registered trademark of Sun Microsystems, Inc.

Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States and/or other countries.

Java and all Java-based trademarks and logos are trademarks of Sun Microsystems, Inc in the United States and/or other countries.

Lotus, Lotus Notes, and Lotus Domino are trademarks of Lotus Development Corporation.

UNIX is a registered trademark in the United States and/or other countries licensed exclusively through X/Open Company Limited.

The following are trademarks or registered trademarks of International Business Machines

- IBM
- AS/400
- OS/400
- RS/6000
- RISC System/6000
- PS/2
- OS/2
- AIX
- AIXwindows
- OfficeVision
- OfficeVision/400

This publication may refer to products that are not currently available in your country. IBM makes no commitment to make available any products referred to herein.

Other company, product, and service names may be trademarks or service marks of others.

(C) Copyright IBM Corporation, 2000. All Rights Reserved.